S. 464.

THE

POPULAR SCIENCE REVIEW.

A QUARTERLY MISCELLANY OF ENTERTAINING AND INSTRUCTIVE ARTICLES ON SCIENTIFIC SUBJECTS.

EDITED BY HENRY LAWSON, M.D.

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CONTENTS OF VOL. III.

Photographic Printing and Engraving. With a Photograph of a Complete Page of the *Times* Newspaper, printed from Stone. By William Crookes, F.R.S. ... ... *Page* 1

Fresh Air. By E. Lankester, M.D. 6

Microscopic Fungi: Parasitic on Living Plants. With Seven Pages of Coloured Illustrations. By M. C. Cooke ... 20, 178, 317, 469

On the Physical Geography of the Ionian Islands. By Professor D. T. Ansted, M.A., F.R.S. 44

The Metropolitan Main Drainage Works. With a Map of the Works. By S. J. Mackie, F.G.S. 56

Diseased Pork, and Microscopic Worms in Man. With Tinted Illustration. By John Gamgee, Principal of the New Veterinary College, Edinburgh 141

Bodily Work and Waste. By Francis T. Bond, M.D., B.A. (Lond.) F.C.S. 149

The Railway Tunnel through the Alps. With Tinted Illustration 157

Greek Fire: its Ancient and Modern History. By B. W. Richardson, M.A., M.D. 164

Notes on Earthquakes. By the Rev. W. S. Symonds, Rector of Pendock 204

On Printing Telegraphs. With Coloured Fac-simile Illustration. By R. S. Culley 293

Herrings and Herring-Fishing. By the Editor 304

On Proper Clothing. By E. Lankester, M.D., F.R.S. 338

On the Absorption and Radiation of Heat. With Two-Page Illustrations. By H. Debus, Ph.D., F.R.S. 351, 498

Botanical Exercises. By the Rev. G. Henslow, M.A., F.L.S. ... 358

Pre-Historic Dwellings. With Tinted Illustration. By George E. Roberts, F.A.S.L. 362

The Aniline Dyes. With Page of Silk Illustrations. By Dr. T. L. Phipson, F.C.S. 429

	Page
On the Action of Manures. By Baron Liebig	438
The Old Red Sandstone Fishes of England. With Tinted Illustration. By E. Ray Lankester	441
Oysters and Oyster-Culture. With Page Illustration. By the Editor...	448
The Pneumatic Despatch. With Page Illustration. By S. J. Mackie, F.G.S.	460
Thermometry. By G. F. Chambers	487
New Inventions	69, 233
Reviews of Books	83, 217, 370, 501
Scientific Summary—Agriculture	381, 514
Astronomy	97, 243, 382, 515
Botany and Vegetable Physiology	101, 247, 386, 518
Chemistry	106, 252, 389, 523
Geology and Palæontology	110, 257, 394, 529
Mechanics	115, 262, 535
Medical Science...	117, 265, 399, 539
Metallurgy, Mineralogy, and Mining,	123, 271, 275, 403, 408, 545
Meteorology	406, 547
Microscopy	128, 274, 409, 548
Photography	128, 276, 412, 551
Physics...	132, 280, 417, 556
Zoology and Comparative Anatomy	136, 284, 422, 561

NATURAL HISTORY.

Plate 1.

SECOND EDITION.

THE TIMES-OFFICE, Friday Morning.

AMERICA.

(By Electric and International Telegraph.)

(From our own correspondent.)

[We are not responsible for the opinions of our Correspondents.]

NEW YORK, August 12.

There is no change in the position of the armies of Generals Lee and Meade. It is stated that General Lee has received a despatch from General Bragg announcing that most of his own divisions in Tennessee, or reported to succeed him.

A rumour prevails that General Meade has resigned the command of the army of the Potomac, and that either General Grant or General Rosecrans will be appointed to succeed him.

General Banks, with the General Staff, and the gunboats Commodore Barney and Clifton, left Vicksburg on the 4th inst., and proceeded up the Yazoo River to reconnoitre Fort Darling. Four rebels were taken on the boat, a number of others were killed on the shore. The Clifton was struck by 32 shot out of the enemy and narrowly escaped her fate. The contest of water batteries on the occasion fell upon each of the Union vessels, and were also unharmed, all of them steaming into open channel.

An effective fire of artillery and musketry from the above was opened upon the fleet, during which upwards of fifty shots and seven were killed or wounded. The fleet was yet above, and under a running fight returned down the river.

The Cairo Post Office of the 8th ult. states that the attack upon Helena, Arkansas, by Generals Holmes and Price on the 4th failed, as reinforcements of the latter town, which rendered the rebels overwhelmingly superior in numbers, arrived in time to prevent the capture of the place. The rebels, after a severe fight, retreated, and were able to prepare for another attack.

Late Confederate journals state that the recent successes of the Confederate arms in the south must have put to rest discouraged the people of the country.

To correspondents for the loss of Vicksburg and Port Hudson it is said to impose an added and very unpleasant burden of fixing artillery to prevent the navigation of the Mississippi.

A correspondent of Atlanta Appeal says that such a case in the river should be evidence of the barbarous or fiendish.

General Lee's losses are reported as being of great confusion and panic, and filled with small cause to have made and unnecessary.

Governor Seymour addressed on the 8th a letter to the Democratic Committee of Albany, in reply to a request of the Committee of the Democratic Convention, declining under the present circumstances to accept the nomination for Governor. He says that the Democratic party of the State will support the present candidate for re-election, as well as to give votes to all for any by endeavouring, by whatever that the Governor will appear with 100,000 majority.

Mr. Lincoln, in his reply, dated the 7th, says, after a letter from Mr. Seymour, he cannot in other hypothesis and argument leading to a system which had proved itself so fallacious as to be called treason, the country was driving every sensational man into the rebel ranks as a leader for treason, and the ambitious man, possessing no army of his own, must necessarily submit to the adoption of a similar course.

In the event of this reply Mr. Seymour appeals to the Democratic constituency assembling for success for the proper administration of the powers of the several States within the district allotted to each's authority.

Many active persons in New York to commemorate the late draft riots, so as to prevent that the work of violence as practised by the rioters of that Committee will again attempt a forcible resistance.

The return of the draft, amongst 27 participating in the recent riots, in that city are among conscripted under Provost-Marshal Fry. Several of the prisoners have been transferred to the Tombs State prison, awaiting their trial before the U.S. court.

Captain Gardner, formerly Military Governor of Port Hudson, and General Dudley, have been ordered to Portsmouth Grove, Rhode Island, to take charge of the body of Major-General Mansfield, who was killed at Antietam. Medical Staff, Colonels, and General Staff, and drag of Lieut. Hazard and the last volley of Salute guns would be expended before the funeral would occur from with the Confederates on the battle of Antietam.

Washington, Aug. 12, 11 a.m.

The President, under date of the 11th, and reports in the annual letter of Governor Seymour, stating that the draft would be suspended in the enumerations concerning the draft.

On the 10th and 11 forces, under arrangement from Washington, by the 18 Campaign commenced to Tennessee, and to Vicksburg, to Tennessee, and to Port Hudson, and has been sent by air passage, and the Mississippi, and the Tennessee, and the Ohio, and there could have been carried to the bay the disposition of their regiment, who had been recruited, and to the approval to secure their return to the command and belonging to Mr. Seymour.

Advices from Mexico of the 7th inst. report no change in the range of that city.

The Commercial of the 8th says:—

"An important meeting of clothing-related persons was held at Washington, on the 7th inst., 18 days, on which place, numerous meeting on the part of the Government, will be attended.

COMMERCIAL INTELLIGENCE.

Thursday, Aug. 13.

Arrived: Hope, Scarborough, 1301; Alice, Pomeroy; The Rose, 1002; New York; Jessie Barbour, 1100; Alice, Pomeroy; Alice, 1100; Jessie, 1100; Scarborough

THE

POPULAR SCIENCE REVIEW.

PHOTOGRAPHIC PRINTING AND ENGRAVING.

BY WILLIAM CROOKES, F.R.S.

THE uncertainty which is a necessary accompaniment of the ordinary method of photographic printing, its great expense, the extreme difficulty of producing a sufficient number of presentable pictures of the same subject to satisfy the requirements of book-illustration, and the utter impossibility, in the present state of our knowledge, of producing a photographic print which can be relied upon for permanency, have caused men of science, from the earliest days of photography, to turn their attention to the problem of causing the photograph to impress itself on a metal plate or lithographic stone in such a manner that the subsequent copies could be struck off in printer's ink.

A somewhat similar problem, but one of far less utility, has been to produce photographic prints on paper prepared in such a manner that the dark portions of the image shall be composed of carbon, or some other body of which it can confidently be asserted that no ordinary atmospheric influences would cause it to change. This latter problem has been followed up with some ingenuity by many experimentalists, both in England and on the Continent; but as they are all open to the grave objection that the mechanical operation of printing is as slow and uncertain as the ordinary process, they need not be further alluded to.

Passing rapidly over the first crude attempts of Donné, Niépce, Berres, Fizeau, Nègre, and perhaps some others, none of which met with much success, we come to the photoglyphic process of Mr. Talbot, the basis of which was first published in the early part of 1853. The principle which he adopted was an entirely new one in that branch of the art; it may be briefly explained as follows:—A solution of gelatine or isinglass, containing a little bichromate of

potash, is poured on to a steel plate and allowed to dry. If one half of the plate be covered with a piece of card so as to obstruct all light from it, and the other half exposed to the action of sunshine for a minute or two, it will be found, on examining the plate in a dark room by the light of a candle, that the portion which has been exposed to the sun has become of a brown colour, whilst the shaded part of the plate remains of the original yellow tint. This is a well-known photographic property of bichromate of potash, and was long ago applied by Mr. Ponton to the purpose of printing photographs on paper. But, besides a change of colour, another alteration will be found to have taken place. When dipped into water, the gelatine and bichromate of potash which have not been acted upon by the light will gradually dissolve, leaving the steel surface quite clean; but the other portion, which has been turned brown by exposure to the sun's rays, will scarcely dissolve at all. If, instead of a piece of card, the leaf of a fern, a piece of lace, or the light feathery flowers of a grass, be pressed in contact with the prepared surface of steel by means of a thick piece of plate-glass, the finest line, even the minutest fibre or thread, will be copied on to the steel surface, and, after being washed with water, will show an eminently beautiful white image impressed upon a yellowish-brown ground. The next step in the process consists in etching this steel plate in such a manner that an impression of the object can be struck off in printing ink. This is a matter of more difficulty than would at first sight be imagined; many chemical agents are known which are capable of attacking the exposed surface of the steel plate, whilst they will have no action on the parts protected by the altered gelatine; but a plate so etched will not give a good impression, except under very favourable circumstances. If the *negative* be a piece of black lace, the finished and etched plate will have a perfect representation of the lace eaten into its surface to a considerable depth, by the action of the corrosive liquid, and if this be given into the hands of a copperplate printer, he will, in all probability, produce from it very beautiful and perfect prints, which at a little distance could not be distinguished from the original lace.

The perfection of this kind of subject is due to the lines of etching formed by the threads of lace being of such a diameter that the ink is properly held by them; but if, instead of a piece of lace, a photographic picture were used, a very different result would be obtained. The steel plate, it is true, would be impressed with an exquisitely beautiful image, and upon applying the etching liquid, the picture would be bitten in with tolerable accuracy; but when tested by the

printing-press, the plate would be found sadly deficient. A careful examination will show where the fault lies. Where the light has acted strongly, the plate is not etched at all; where the light has not acted, the plate will be corroded very deeply; and if this portion represent fine lines, such as the branches of a tree or a row of palisades, the ink will be held by them, and produce a good print; but if a *surface* of the plate be etched in this manner, there will be no means of holding the ink, and that portion will not, therefore, give an impression. Again, a half-tint will be represented on the plate by a uniform corrosion of the surface to a slight depth; but for printing purposes, half-tints of various degrees are required to be represented by lines or dots of different distances apart.

This difficulty besets all processes for photographic engraving; pure black and white can be given easily enough, but the half-tints, which constitute nine-tenths of a good photograph, have puzzled many experimenters to master. Talbot partially overcomes this difficulty by producing an artificial aquatint ground on the plate, either by impressing it with the image of two thicknesses of black lace crossed diagonally, or by spreading very evenly over the surface of the plate a little finely-powdered gum copal, and then heating it. In this manner the ink is enabled to adhere to those portions which constitute the half-tones of a picture; and by adopting either of these artifices, the photoglyphic process, as Mr. Talbot terms it, has yielded results which, in the hands of a skilled operator, and on small plates, can scarcely be surpassed.

The photogalvanographic process of Pretsch is somewhat similar in its commencement to the one just described. A plate of glass, or other smooth surface, is coated with bichromate of potash and gelatine, and afterwards exposed to the light under a photograph or an engraving; it is then moistened with water, but not thoroughly washed. The first action of moisture is to cause those portions of the surface which have not been exposed to the light to swell and rise up, more or less, in ridges from the surface of the plate. A mould is then taken of the plate so raised; from that an electrotyped copper-plate is procured, which is used as a matrix, from which other plates may be produced suitable for printing purposes. The gelatine in swelling is found to split up into ridges, giving to the whole surface a granular effect, which holds the printing ink equally well in the fine lines and the broad masses of shadow. This process gives very effective prints when they are large and are viewed from a distance, but for fine, delicate work it is not so successful.

Another process has been brought to considerable per-

fection by Sir Henry James, in the Ordnance Office, Southampton, where it is used for producing copies of maps. A mixture of gelatine and bichromate of potash is in this case also the foundation. A surface prepared with this mixture is exposed to the action of light behind a transparent photograph of the map, or other object to be copied, which is tightly pressed against it. The change which has been already described soon takes place, and a roller charged with lithographic ink is then passed over its surface. This blackens the whole surface; but when it is soaked in warm water, the portions of the sensitive coating which remain unchanged by the action of the light are dissolved out, and the lithographic ink is thereby removed from those parts of the picture. A flat prepared surface of zinc is then placed in contact with the inked picture, and the two are submitted to heavy pressure, when a complete transfer of the impression will be found on the zinc. After suitable preparation, any number of copies can be printed from this zinc plate in ordinary lithographic ink. This process is capable of giving very perfect results, and when applied to the copying of manuscripts, prints, or similar matter, it is impossible to conceive a more perfect reproduction. Indeed, it is no easy matter, when the original and the photozincograph are placed side by side, to distinguish one from the other; and if the copy have been reduced in size by photographic means, most persons would prefer it to the original, both in point of delicacy and sharpness.

The last process which it is necessary to mention is the discovery of Mr. Dallas, and called by him photo-electric engraving. No explanatory details are given by the inventor, but there is little doubt, from the results already exhibited, that it is a modification of one or both of the photoglyphic and galvanographic processes. The great difficulty has always been to present the half-tones. Mr. Talbot's process, it is true, solved this almost perfectly. Before us is a print representing a portion of the palace of the Tuileries. The richness of the sculpture, the number of the statues, and the numerous fluted columns, render this an exceedingly difficult subject to engrave by a chemical process, owing to the great variety of tints which it presents; and it affords ample evidence that this kind of photographic engraving is capable of rendering the most delicate gradations of tone, and the accurate delineation of details as perfectly as the bolder outlines of the picture. Confining the scrutiny to certain portions of the picture, the effect is quite equal to any photograph printed in the ordinary way, which is giving it the highest possible praise; but when the picture is viewed altogether, it appears patchy and unevenly developed. Owing

to the difficulty of overcoming this defect, photoglyphy is now but very little heard of. Mr. Dallas seems in a great measure to have succeeded in overcoming this want of evenness, and has produced pictures which, regarded as a whole, must be considered very satisfactory specimens. They will not bear microscopic examination, as do many of Mr. Talbot's; but, as pictures, they are much superior to any untouched specimens produced by either of the processes above alluded to.

An art like this is still in its infancy. As soon as a method of photographic engraving comes into general use for book-illustration, improvements will follow one another rapidly; the faults above pointed out are, in a great measure, due to inexperience or defective manipulation, and would vanish as soon as a demand arose amongst the public for such illustrations. The general adoption of a process of this kind would be invaluable: an engraving of any object or scene, however good the artist may be, is not and cannot be an exact representation; at the best it is but a mere approximation to that, and there is always a tendency for the artist to idealize the subject and render it difficult to recognize at first glance; and he cannot descend to those minutiæ of detail which give such a charm to the photograph. The great value of photography is that it produces absolute fac-similes; but this value is lessened by the tedious rate of reproduction, and the great probability that in twenty years' time upwards of ninety per cent. of the photographic prints now in existence will have faded out. By wedding engraving to photography, and making the same physical and chemical agencies which impress the sensitive tablet produce the engraved plate, the mathematical accuracy of form and detail possessed by the photograph is secured, united to the permanence of a printed book.

For the illustration of objects of natural history, flowers, plants, and animals, even to the most minute microscopic object, this invention is invaluable. By its means fac-similes of rare engravings or manuscripts are even now, as in the case of "Doomsday Book," multiplied to any extent, and circulated amongst the public at a price which formerly would not have paid for the commonest woodcut.

The plate given with this article is perhaps as perfect an illustration of the accuracy and delicacy of photolithography as could well be produced. An ordinary page of the *Times* has first of all been copied photographically, and then transferred to stone, the copies being subsequently printed off as lithography.

FRESH AIR.

BY E. LANKESTER, M.D.

OF course, all the readers of the POPULAR SCIENCE REVIEW will feel that a chapter on fresh air is quite superfluous. Sensible and cultivated people are insulted if you hint to them that they are not fully acquainted with the benefits of fresh air. Yet it is so constantly the case that sensible and cultivated people do not ventilate their sitting and bed rooms, do occasionally suffocate their babies in bed, and have children who suffer from all forms of scrofulous disease, and grown-up sons and daughters dying of consumption, that I feel it is not superfluous to write on this subject for them. I want them to reconsider the grounds of their belief in fresh air, and to see whether they have yet arrived at a due conviction of its importance. Have they fully considered the import of the fact, that their own life and that of the whole animal kingdom depends on the air in which they live; and that depriving them of it for two or three minutes destroys this life? In the great world into which all are born, God has made ample supply of this air: the waters of the sea are filled with it; and wonderful are the devices for securing a due supply of fresh air to the blood of the fish and the creeping things which abound in all waters. If we could all live in the open air, we should always have fresh air and secure a natural ventilation. But man requires heat. It is economy of food and strength to him to keep himself warm; and in listening to his instinct for warmth he has forgotten to provide, at the same time, fresh air. His warm clothes do him no harm; but directly he hides his head under a covering, whether it be in a mud hut or a palace, his sorrows from impure air begin. Under these circumstances, his own breath, which flows away from him in the open air without injury, is retained and breathed again. All the comforts, the luxuries, and necessities of his life are sources of danger to him whilst he is in his house. His curtains, his carpets, his furniture of every kind, collect the particles of matter which, rising into the air, render it impure. If the goddess of cleanliness herself were installed in every room of every house, she could not prevent the air from being rendered

impure by the constant and unseen action of these dead and living particles of matter.

"But we know all this!" I hear my sensible friends exclaim. Then why do you not act on it? I am writing this by the sea-side, and my house is one of a row that looks on to the sea. Regularly as the sun sets, my friends all retire to their houses, the last of the chicks is put to bed, and then all the windows and doors are duly closed. Last night the temperature was about 65° Fah.; a gentle south-west wind was blowing from the sea—to be sure, it made the candles flicker, but it was delicious to the feelings. I passed along the row of houses: it was truly a melancholy sight. Not a door, not a window, was open! Now, houses at the sea-side are not built very durably, and a sea breeze will, no doubt, penetrate the rooms, lock and bolt them as you will. Nevertheless, there is not enough air penetrating these little rooms to take away the close smell of food, and dress, and human exhalation, and, above all, the gases which rush into the warmed house from every drain and dustheap about the premises. To be sure, the children in these houses are looking well, and the doctor is not often down from the neighbouring village; but this I know, my neighbours' children are not so well as they might be. But "Doctor, do you not think the night air is injurious?" "No, madam, I do not; and if it were, I do not see how your candles and closed rooms are to improve it." "Yes," said a lady to me, a short time ago, "fresh air is so important for poor people; but we who live in large rooms do not require that amount of ventilation!" It was evident she thought what she said; for on examining the sashes of the windows of her splendid house, not one of them came down from the top. Impure air is, no doubt, a worse thing for the poor than the rich; for the ignorant, perhaps, than for the learned: but it is a bad thing for all. It is no comfort, when you are half-suffocated in Burlington House, at a soirée of the Royal Society, to know that the most learned and scientific men in Europe are suffering at the same time with yourself. What every sanitary reformer must feel of the utmost importance is, that sensible people, who talk about fresh air for the poor, should set a good example, and value it for themselves.

Let us, then, go over the foundations of our belief in fresh air, so as to be able to understand thoroughly the dangers arising out of its impurity. The pure air of the atmosphere contains four constituents, two of which are constant and two are variable. The two constant constituents are oxygen and nitrogen gases. They are in the proportion of twenty-one of the former to seventy-nine of the latter. The nitrogen is passive,

remaining in an unchanged condition in the air; but the oxygen is ever being consumed and renewed. By its union with carbon, and other elements of the animal body, it maintains life. Just as it unites with the coals of the fire or the carbon of the gas and gives out heat, so it unites with the carbon of animal bodies and heats them, and they live. The result of their life is carbonic acid, which would poison the animal and the air in which it lives, were it not for the agency of the vegetable kingdom. That which is death to animals is life to plants. The carbonic acid enters the plant as a compound of carbon and oxygen; but each cell of the plant is a chemical laboratory, where invisible forces are busily at work, separating and depositing the carbon as future store of food for man and beast, and the oxygen is set free. The oxygen is thus restored to its home in the air once more, again to be conquered by carbon, and once more to be set free from its prison in the plant-cell, when touched by a ray of light from the sun. But not as it enters the lungs of man or animal does oxygen come forth from the plant. It has acquired new powers, and, like a giant refreshed, is more capable of action than before its repose. It has now become *ozone*. It is still oxygen, but oxygen capable of oxidizing more powerfully, of acting more vigorously than it does as it ordinarily exists in the atmosphere. Ozone is soon lost in the great ocean of air into which it is thrown, by its own activity. It is found on mountain heights, it is found by the sea-shore, and on the sea; but it is consumed by cities, by cultivated land, by forests, and by all agencies which call its vigorous action into existence. But wherever it is found, it acts favourably on the human body. The instincts of the denizens of cities and valleys have drawn them to mountain heights and sea-shores; and the annual migrations of families to our hills and sea-sides have excited the ridicule or the reflection of those who have never attempted to solve its real cause. The air of mountains and sea-sides is doubly fresh air: it is not only pure, but ozonized, which accounts for its curative and exhilarating action on the human body. It is interesting to know that this universal instinct of benefit to be derived from residence in these positions has been confirmed by elaborate physiological experiments on the human body. It is now known as a fact, that those actions of the body which are essential to healthy life are carried on more vigorously in an atmosphere containing ozone. The great practical lesson taught by this knowledge is, the importance of securing as often as possible change from an unozonized to an ozonized atmosphere; and it is especially important to those whose opportunities are limited, that when they are at the sea-side, they should exclude, no

more than is absolutely necessary, the action of this beneficial agent on their system.*

Let us now consider the variable constituents of our pure atmosphere. These are carbonic acid gas and the vapour of water. We have seen that carbonic acid is constantly being thrown into the atmosphere by the breathing of animals. There are several other natural sources of this agent. All the putrefaction and fermentation of animal and vegetable substances is attended with the evolution of this gas. There is another natural source, and that is volcanic action, which is constantly supplying this gas. Of the gases which are thrown out from volcanoes, this is most abundant. It is one of those sources of carbon and oxygen to the surface of the earth which will account for a phenomenon not otherwise easily explained, and that is, the constant increase of organized beings on the surface of the earth. When Adam and Eve alone occupied the earth, about thirty-five pounds of carbon sufficed to organize the whole human race; but now we have 500,000,000 times that quantity in men and women alone. Add to these the domestic animals by which they are surrounded, it will be seen that the demands for carbon upon the atmosphere through the vegetable kingdom has been enormous, and has constantly increased. The never-failing supply of this carbon is volcanic action. Thus, we see that the increase of man on the earth, and his hope of multiplying in ages to come, is dependent on that action which produces volcanoes and earthquakes. Thus it is that the very phenomena which have sometimes been regarded as proofs of the wrath of God in a fallen world are blessings, abounding with all possible goodness to the human race.

These natural supplies of carbonic acid gas are supplemented by others produced by man himself. He consumes carbon for cooking, warming, and manufacturing purposes, and it has been calculated that a thousand millions of men consume yearly upwards of 2,000,000,000,000 of pounds of carbon. This quantity is again increased by artificial fermentation, by tobacco-smoking, by lime-burning, and other sources, to a prodigious extent, when we calculate the real quantity consumed. Yet, all this carbonic acid, were it allowed to accumulate, would form but a small quantity in the great aerial ocean by which we are surrounded. In the pure air of the Alps and of the sea it forms but about a fortieth per cent., by

* In some experiments made at Brighton, in 1862, I found in a room with the window open, that whilst ozone test-paper was readily coloured at the open window, it was not changed at all at the back of the room, showing that the impurities of the atmosphere of a room with an open window were sufficient to destroy all the ozone that entered it.

weight, of the whole atmosphere. In the neighbourhood of towns and districts where this gas is produced, either artificially or naturally, a larger proportion of the gas is found.

The vapour of water is constantly present in the atmosphere. It is present in small quantities in the driest atmospheres, and during rain the atmosphere is saturated with it. In its largest quantities it is not an impurity. It nevertheless exercises a most important influence. The quantity of heat that falls upon the surface of the earth is regulated by the quantity of moisture in the air. Heat is conducted much more rapidly from the body in a moist than a dry atmosphere. It is, however, in the power that the particles of moisture possess in taking up and retaining organic matter and various gases, that its influence is seen in rendering the air impure. It is in damp states of the atmosphere that poisons most readily traverse its currents, and that all the destructive agents which render air impure are most rife. It is the prevailing moisture of the atmosphere of the British Islands which renders their inhabitants more liable to the injurious influences of impurities than in countries where the temperature of the air is greater, but where the prevailing moisture is less. The atmosphere, however, is not rendered impure by the less or greater quantity of moisture it contains.

Having surmised thus much of pure air, we are now in a position to judge of the nature of those impurities which render it injurious to animal life, and are more especially dangerous to human beings. We may divide these impurities into those which are gaseous and those which are solid, and speak first of gaseous impurities.

The first of these which I shall refer to, and which is by far the most commonly injurious, is carbonic acid gas. We have seen what are the sources of this gas, and that in small quantities it exists naturally in the atmosphere. It cannot, however, be greatly increased without danger to health. The most common source of its increase is the interior of houses and buildings where human beings are gathered together. Human beings, when placed in rooms, are constantly consuming the oxygen of the atmosphere and throwing into it carbonic acid gas; thus, if means are not taken to get rid of it, it accumulates and takes the place of the oxygen consumed. The system is thus exposed to a diminished supply of oxygen and an increased supply of carbonic acid. Although carbonic acid can be imbibed with impunity in the form of effervescing beverages, as soda-water, ginger-beer, or champagne, there is no doubt of its deleterious influence when inhaled by the lungs. The destruction of English prisoners in the Black Hole at Calcutta is an eminent example. Other

instances of the wholesale destruction of human life by confinement in small spaces are well known. Within the last few years the captain of a sailing packet between Ireland and Liverpool, whilst in a storm, shut down his passengers in the hold of a vessel, and when opened again, a large number were found dead. The inhalation of less quantities of carbonic acid produces a depression of the vital powers of the system, which lead to those diseases known as scrofula and consumption. In the annals of French Hygiene the case is recorded of a village in the Pyrenees remarkable as exemplifying the influence of impure air on health. The village was one built in a small valley or depression of the hill, so that there was no ventilation or entrance from the backs of the houses at all, and the doors all opened into a court formed by the houses. Though situated on the mountains and inhabited by shepherds and their families, this village was remarkable for the prevalence of scrofula and consumption, and its great mortality. Providentially, a fire consumed one side of the village, and advantage was taken of this occurrence to build the houses above, on the side of the hill. No sooner was this done than the health of the inhabitants began to improve. The change was so great that the authorities determined on pulling down the other side of the old village, and rebuilding it on the top of the hill. The consequence has been that there is now no healthier village in the district where it is situate.

The case is the same in all our towns and cities: where the population is thickest, and human beings are crowded together, there disease and death prevail most. I might illustrate this assertion by the returns of the Registrar-General, and the reports of the Medical Officers of Health for London and the Provinces. In the parish of St. James, Westminster, there are three districts, in one of which there are 130 persons living on an acre, in the second there are 260 on an acre, and in the third 430 persons on the same space. In the first district there are 11 deaths only in the 1,000 every year; in the second there are 22 deaths; in the third there are 25. The death in the whole district from consumption is one in every 344 of the population. The death in the whole of London is one for every 371 of the population; but to show how fearfully the overcrowding of the third district tells on the life of the community, the death from consumption in the third district is one in every 280 of the inhabitants.

Another form in which the direct effects of carbonic acid on life is most fearfully seen is the suffocation of children in bed. Between two and three hundred children are annually found dead in their beds in London. This suffocation occurs in

various ways, but in all instances it illustrates how terrible a poison the breath of a sucking babe is, from the carbonic acid it contains. The maternal instinct of the mother leads her to care for her child; but, alas! in her ignorance, she too often destroys its life. Frequently the child is found dead on her breast; for whilst providing for its nourishment she falls asleep, and the fresh air being excluded from the nostrils of the child, it dies from the carbonic acid circulating in its frame. More frequently the child is covered over with bed-clothes to keep it warm, thus preventing the natural escape of the carbonic acid, and it is poisoned as surely as the men in the Black Hole of Calcutta. Even a handkerchief thrown over a child's face is sufficient to prevent the escape of the poisonous air, and children are smothered by the attention which is intended to keep off the flies, or a draught of air.

The evils of an accumulation of carbonic acid gas are very great from the deficient ventilation of our places of public assemblage, and our dwelling-houses. Amongst public places, churches, chapels, theatres, and courts of law may be named as most exposed to the evils of an atmosphere corrupted by carbonic acid. Our places of worship are seldom constructed with any reference to the dangers that may arise from the atmosphere being contaminated with carbonic acid gas. Every available space is used for sittings, and at night they are lighted with gas, thus adding another source of carbonic acid to that of the breathing human congregation. Large and ample provision should be made in such places to allow of the escape of the noxious carbonic acid and the access of the pure oxygen. It is not the heat of these places which renders them so unpleasant to the large proportion of the audience, and occasionally sends a delicate female or aged person out fainting, or the more healthy to sleep; it is the accumulation of carbonic acid gas. There is, however, a limit to the exposure of persons to this atmosphere in the necessary conclusion of the religious services, and persons in ordinary health recover the effects of the poisoning before they are again submitted to its influence. It appears to me to be a first duty of church-wardens, deacons, or committees to whom the comfort of these places is committed, to see that persons engaged in the service of religion should not be injured by such service or prevented altogether attending a place of worship from its notorious want of salubrity.

Our theatres are more dangerous than our places of worship. There gas-light always adds its quantum of poison, and people sit for five or six hours without any change of atmosphere. Recently great improvements have been made in many of the metropolitan theatres; but, throughout the country, theatres

and other places of public amusement are terribly exposed to atmospheric contamination.

Our courts of law have been perhaps less cared for than any other public buildings. This is almost unaccountable, when it is considered that they are constantly occupied by the members of an intelligent profession, whose health and life are in a great measure dependent on the freedom from impurity of the atmosphere of these places. One would be inclined to recommend, in these cases, Government interference, seeing that justice itself may not be unlikely to miscarry when a judge has to sum up or pronounce a sentence with his blood poisoned with the fumes of carbonic acid.

If we turn now to our places of business, our workshops and our factories, we shall find the same crowding and the same lighting and injurious effects much more permanent. In many of our factories, children and girls are crowded together, and little or no provision is made for ventilation. It is among the workers in these rooms that the forms of scrofula and the deadly consumption of the lungs are known to spread desolation. Many of our factories and workshops are well ventilated, but the majority are not. No law has yet been passed that will touch them. The workshops not only exist in our manufacturing districts, but in London and all our great towns. Where sedentary trades are carried on, there workmen and workwomen are collected together, almost in every case, in rooms too small, and without provision for ventilation. An examination of the returns of the mortality of any district in which there are sedentary workers will show how fearfully they suffer from consumption as compared with other classes of the community. There are, no doubt, other agencies at work; but eliminate these, and the great source of the deaths from consumption will be found in the presence of carbonic acid in the atmosphere.

Another class of rooms where ventilation is frequently neglected, to the prejudice of the health of the temporary occupants, are schoolrooms. The benefit found to accrue from discharging children every hour for a few minutes does not act more beneficially on their minds than it does on their bodies. The few minutes out of doors gives the children an opportunity to get fresh air, and to the judicious schoolmaster an opportunity of thoroughly ventilating the room.

But perhaps our dangers are as great at home as anywhere. The sitting-room of the tradesman, the common room of the mechanic, the drawing-room of the wealthy, and the sleeping-rooms of all, are not ventilated. Many of them are not deficient in the means of ventilation; but, as a rule, the home of the Englishman is poisoned by the gas exhaled from his

own lungs. Let us take sitting-rooms first. To be sure, in very cold days in winter, when fires are in the room, and in very hot days in summer, when the windows are opened, the air is well changed. But there are the warm days in winter, when the fire is let out, and the cool days in summer, when the windows are kept close, and the whole of the spring and autumn months; and at these seasons the Englishman's sitting-room is filled with an atmosphere injurious to his health. If he has a drawing-room, the only set-off to this state of things is found in its size. If he has, however, a drawing-room, he will probably give parties or soirées; and perhaps it is on these occasions that his utter ignorance of the worth or value of fresh air will be most obvious. The drawing-room is generally lighted with gas, which is turned on to the highest point, and then the room is crowded with visitors, even on to the stairs. The atmosphere is cruelly oppressive, the guests are almost fainting; but the suggestion of an open window—of a draught—is repudiated as something offensive to the delicacy and amenities of genteel life, and fresh air is voted by all as vulgar and a bore. I am quite aware of the danger of sitting or standing in a draught, although I believe that is much exaggerated; but rooms are to be ventilated without draughts; and if not, people need not get into them. The colds you take at parties are not the result of draughts, but the very opposite. The majority of colds arise from the want of pure air, and not from cold or cold air.

But we pass from sitting and day-rooms to bed-rooms. It is here that everything is done to keep in carbonic acid and to exclude oxygen. What with the smallness of some rooms, the destitution of fireplaces, and windows that will not open, beds with posts and curtains, and blinds, the bed-room may indeed be called the Englishman's Black Hole. The insane fear of a draught, with the delusion that night air is prejudicial, undoes almost everything in bed-rooms at night which may be done by open-air exercise or healthful occupations in the day. The sleeping-rooms of the rich are frequently kept so close that even domestic animals would suffer, were they compelled to sleep in them, whilst those of the poor are so odious that it is almost a wonder health is ever found amongst their occupiers. This terrible disregard of the purity of bed-rooms is seen everywhere:—in the hammocks of our ships, in the cottages of our labourers, in the barracks of our soldiers, and in the houses of the middle classes and the opulent. The neglect of the ventilation of bed-rooms is as common among sensible people, who flatter themselves they know the value of fresh air, as among the helplessly poor and ignorant of our population.

As for the injury done by other gases, that is so little and so exceptional that I need hardly refer to them. Wherever sulphuretted, phosphuretted, or carburetted hydrogens appear, they are indicative of the presence of other matters in the air more injurious than themselves. I shall not therefore dwell on them, but turn to the solid particles which render the air impure, and with which these gases are often associated. These solid particles are so minute that they can only be apprehended by the microscope, and many of them, even by that instrument, are not sufficiently made out to be easily distinguished. They are derived from organic or inorganic sources. The organic are derived from living or dead animals and plants. The particles thus given off are exceedingly minute, and appear to be held in suspension by molecules or small particles of water. The emanations of living animals are constant. The epidermis of the skin flies off into the air, as well as particles from the lungs in the breath, so that the air where large numbers of animals exist becomes charged with such exhalations. The human body is no exception to the law. These particles are capable of decomposition, and when taken again into the living system, may be absorbed and lead to febrile disturbance in the system. These particles are given off from diseased bodies in such a state that they generate diseases in other bodies like those from which they have come. It is in this way that zymotic diseases are propagated, and scarlet fever, small-pox, measles, hooping-cough, and typhus, are all conveyed in this way.

Dead animal matter gives off also particles, not equally destructive of life, but which may, nevertheless, produce the most virulent diseases. Typhoid fever is the offspring of decomposing animal matter. The particles which produce it steal up from our drains and cesspools, and make their way into the studios of the scholar and the chambers of royalty; no class or condition of persons are spared the influence of this dreadful poison.

Vegetable matter decomposing emits still more destructive poisons. The malaria of our own marshes, and its deadly representative in the Campagna of Rome, with the miasma escaping from the swamps of Africa and the jungles of Asia, are all of vegetable origin. Plants decomposing in contact with water yield this dreadful agent, which contaminates and renders deadly the purest of atmospheres.

Another set of particles which may come from animal, vegetable, or mineral sources, are those which we call dust. Dust is not only unpleasant—it is dangerous to life. The workers in coal are liable to disease in the lungs, from the particles of coal-dust accumulating in the lungs and producing

an arrest of their functions. The same is the case with the knife and scythe-grinders of Sheffield, who get the dust of iron and stone into their lungs. The workers in wool, cotton, linen, horse-hair, or any of the materials that are taken into the air in fine particles, are all liable to consumption, from the accumulation of these foreign substances in the air-passages of the lungs, and the consequent exclusion of oxygen from the blood. Even the dust of ordinary rooms, from carpets, furniture, clothes, curtains, and other things, becomes a source of impurity of air in our houses, and adds to the destruction of health which goes on from the presence of carbonic acid.

One of the most common causes of impurity of air from these particles is the unconsumed carbon in the atmosphere of towns and cities. It is these particles which blacken linen and all white furniture, and the wool of sheep's backs. It exists in such quantities in London, that the air may be filtered through fine muslin, and pure carbon collected in considerable quantities. It is possible to strain the air of a house, and get rid of all these particles. I know one gentleman in the City who uses a steam-engine on the premises for the purpose of forcing the air through metallic sieves before it enters his house. The consequence is, that directly you enter his door, the air has all the purity of that at the sea-side or the mountain-top; and instead of the oppression which all London air gives, you feel invigorated. This shows what may be done, even in the heart of the City. The fact is, air is like water: you may contaminate it by suspending impurities in it; but when these are withdrawn, it remains as pure as ever.

The question then comes, if impure air is so dangerous, how are we to render the air we breathe pure? How can we get fresh air? In the first place, every one should be impressed with the fact, that the open air must always be more pure than the air of houses, or any confined space whatever. The atmosphere in Cheapside is infinitely purer than any inhabited drawing-room at the west end of London. As far as fresh air is concerned, a party of ladies and gentlemen would be more healthfully occupied in looking at the omnibuses from the curbstones in Fleet Street than in the most elegant dining-room in Belgravia.

The night air of Houndsditch is freer from carbonic acid than the sleeping-rooms of Mayfair. Hence the importance of getting as much into the open air as possible. Children, provided they are warm, cannot be too much in the open air. It is a most merciful act to take little children from their close homes into the open parks; and this has been done in London with the greatest possible advantage. A committee

of the Ladies' Sanitary Association has raised funds by which it has been enabled all the fine summer weather to send parties of poor children into the parks. Of the danger of keeping children indoors I had a good illustration a few weeks ago. I had occasion to compare the health of two streets, one a street with well-to-do artisans and small tradesmen, the other a tumble-down street where lodged the very poor. To my great surprise, the children of the very poor were less sickly and died less than those of their better-off neighbours. On examining the mothers of these families, I got what I think was a satisfactory explanation. The mothers of the poor children confessed that their children were seldom or never indoors; but few of them went to school, and they consequently spent their days in the street. The more opulent class kept their children out of the street and sent them to school. Of course, no rule can be laid down as to the number of hours people ought to keep in the open air, but there can be no doubt of the soundness of the advice—"Get as much as you can." Get it for yourselves, get it for your neighbours. Let the Government, let corporate bodies, let munificent individuals do what they can to tempt men and women into the parks of great towns and neighbouring fields. Above all, let there be attractions sufficient to draw men and women from the public-house, from the dancing-saloon, and other vicious places, where, in addition to the poisoning atmosphere, there is the poisonous drink and poisonous morality. Would that in England a taste for light refreshments could be given to the population, so that tea and coffee, with honest nutritious viands, could be substituted for the present system of drinking beer and gin—a system that annually destroys hecatombs of our hard-working, honest, intelligent artisans. It is especially on those whose occupations are sedentary, and to whom fresh air is most necessary for health, that this destructive habit entails its greatest evils.

A more difficult thing to do is to keep the air of houses fresh. The multitudinous things it involves, and its apparent simplicity, are the great difficulties with which this practice has to contend. We call the act ventilation, and most intelligent people believe their houses are ventilated. If they did not they could not rest a moment. They would not lie down in their beds at peace one night if they thought the evils I have spoken of as resulting from want of fresh air were coming on their families. Nevertheless, I will put this question to them,—Do you believe for one moment that with your closed windows and doors, with your brick drains or your cesspools, with your dustbins, and your dirty (I mean no ill compliment, it is too true) furniture, that the air of your rooms is pure?

The air of London is dirty and impure enough, but what is it as it passes from your window crevices, the key-holes of your doors, and the tiles of your house? Dirtier and more impure than ever. If you say it is not impure, you are wrong; if you know it is impure and talk of the ventilation of your house, it is cant.

I know of no means by which a house can be naturally ventilated without superintendence, or machinery. The system of pumping into public buildings warm pure air, and pumping out the impure air is to be commended, as it secures by the same machinery both warmth and pure air. Whether anything of this kind can be done for private houses is at present very questionable. In the meantime, houses ought to be built so that an ordinarily intelligent person, who understands that hot air ascends and goes out at the upper apertures of a room, and that cold air comes in from below, can so arrange that there is a perpetual flow of air through the room without creating cold by draught. This can generally be done in rooms where the window sashes come down from the top in two sides of a room, or in one side where a door opens at the other. But, alas! how many houses are thus constructed? Not one in a hundred in town or country. When they are so constructed, the sashes are not let down from the top. The bed-rooms, which have been closed up all night, are indulged with a small quantity of fresh air by a little opening from below. The consequence of all this closing of doors and windows is sickness. The children are ill in the nursery, the servants are ill in the kitchen, and the master and mistress are ill in the drawing-room. The source of this sickness is easily understood, if you recollect how large a portion of time the inhabitants of houses spend indoors, and it is precisely those who take least exercise or go out least that suffer most.

The same arrangements in houses that secure the influx of oxygen from without, and the efflux of the carbonic acid from within, also secure the escape of those solid particles which are so injurious when contained in any considerable quantity in the air. It is a well-known fact, that you may so dilute the poison of various fevers, as they escape from the bodies of those attacked, that no one shall be injured by it. If you place one patient with fever in a large ward, no other patient gets the disease, but if you place several fever patients in the same room, then every person that enters may catch the fever. So it is with the poisons of drains and cesspools. If they be well diluted in the open air nobody suffers, but let them concentrate themselves in a room and destruction takes place. I say safety is secured by ventilation in houses otherwise dangerous, but no wise man would allow his drains or

cesspools to leak into his house. But how many men in a thousand see to these things? how many women? how many servants? My experience tells me very few. This accounts for the faint odours and sickening smells that so often salute you in the houses of the rich as well as the poor; of the medical man, who has yet to learn how to apply the laws of physiology to the maintaining the health of his own household, as well as the poor mechanic, who is alike ignorant of the cause of the unhealthiness of his family, and powerless to remove it if he did. And yet, how angry people look if you tell them their houses are "nuisances, injurious to health." They believe in fresh air, they talk of the advantages of fresh air, but they have yet to learn how little they have of it at home, and how much more of it they need if they would secure the health and strength their Creator intended they should enjoy.

But I must bring my sermon to an end. I have thrown these few remarks together as free from technical terms as I could, in the hope of calling the attention of the intelligent readers of the Popular Science Review to a subject still greatly neglected. The more I see of the interior of our households, especially in London, the more I am convinced this subject is not fully understood. I have named only a few of the diseases which arise from deficient oxygenation of the blood, or, in other words, from want of fresh air; and it is only when this subject is more thoroughly comprehended by all sections of the community that we shall find the effects of sanitary reform really telling on the health of the community. At the same time, I am not unaware of the danger of treating a subject like this independently of the questions of food, exercise, warmth, and clothing. Fresh air is valueless without food, it will fail without warmth, and from these considerations the greatest of all practical measures for securing health is the inculcation on the minds of youth those laws by which God regulates the existence of the human body. From every pulpit in the land there issues, once a week, the voice of the preacher inculcating obedience to the moral law of God, and it is to an equally systematic enforcement of the importance of obedience to the natural law that we must look for deliverance from those evils which follow its violation.

MICROSCOPIC FUNGI.—PARASITIC ON LIVING PLANTS.

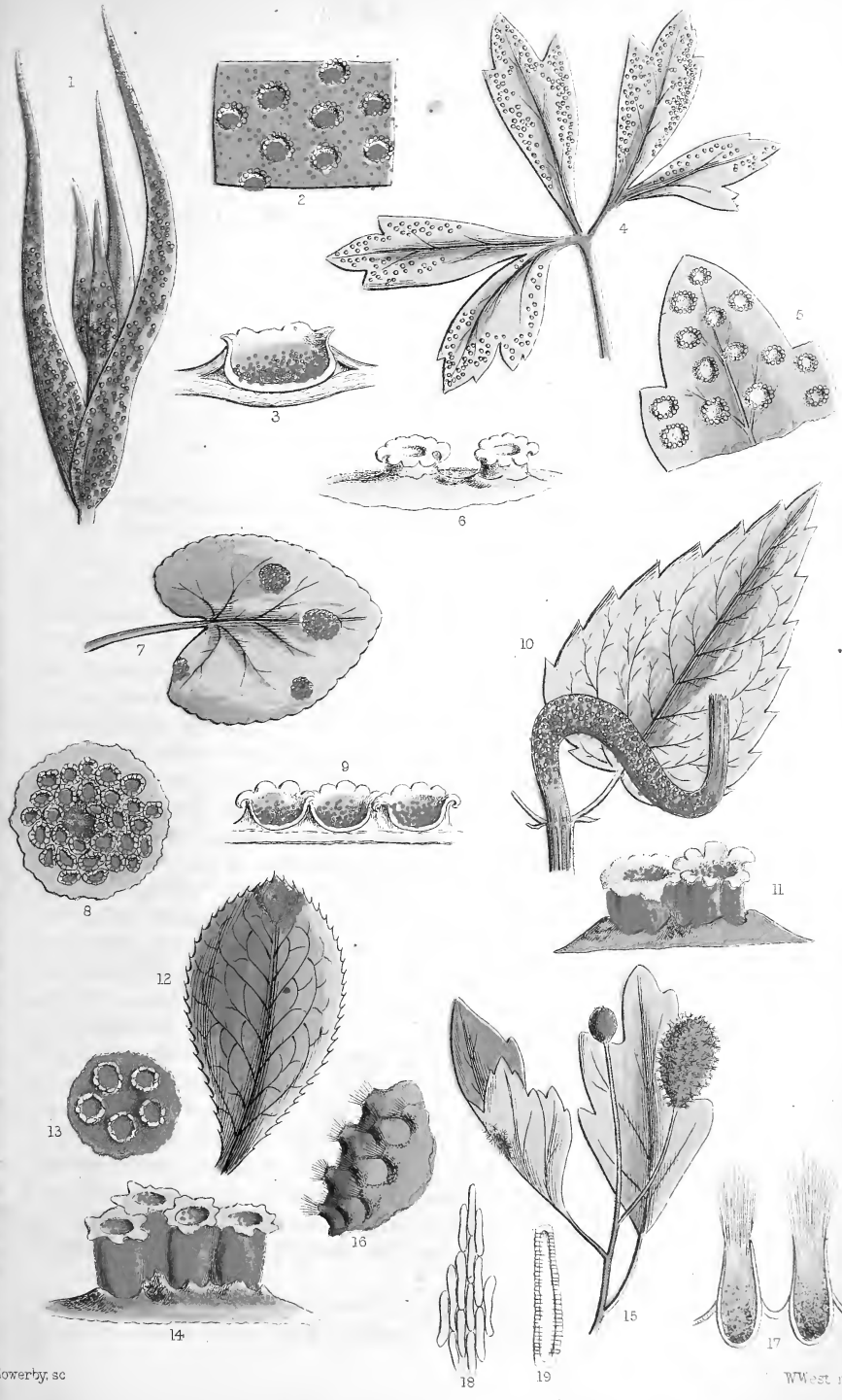
BY M. C. COOKE.

CHAPTER I.

CLUSTER-CUPS.

IN these latter days, when every one who possesses a love for the marvellous, or desires a knowledge of some of the minute mysteries of nature, has, or ought to have, a microscope, a want is occasionally felt which we have essayed to supply. This want consists in a guide to some systematic botanical study in which the microscope can be rendered available, and in which there is ample field for discovery, and ample opportunity for the elucidation of facts only partly revealed. Fungi, especially the more minute epiphyllous species, present just such an opportunity as many an ardent student would gladly take advantage of; one great obstacle to the pursuit being hitherto found in the absence of any hand-book to this section of the British flora, embracing the emendations, improvements, and additions of the past twenty-seven years, the period at which the fifth volume of the "English Flora" made its appearance. It would be incompatible with the aim and objects of a quarterly journal of popular science to introduce an entire mycological flora to its readers in its consecutive numbers; but we hope, in the course of this and one or two succeeding papers, to communicate such information as will serve to prepare the way still more for such an addition to our Flora, should it ever be produced, and render the demand still wider and more general for such an extension of our botanical literature. It is true that one work has of late years issued from the press on this subject, but notwithstanding its utility to scientific men as a record of species, it is practically useless to those we address, from the absence of all specific descriptions of microscopic fungi.

Let not the reader imagine, from what we have just stated, that it is our intention to burden him with a dry series of



J. Sowerby, sc

W.West imp

Cluster-Cups.

botanical descriptions. Useful and essential as they may be, we hope to be enabled to furnish something more; and although we at once disclaim any intention of including all the microscopic, or even the epiphytal fungi, in our observations, yet we trust, by a selection of common and typical species for illustration, to demonstrate that the microscopist will find an eligible field for his observations in this direction, and the botanical student may gain some knowledge of their generic distinctions.

It is exceedingly difficult to give a logical definition of what constitutes a fungus. It is no less difficult to furnish a popular description which shall include all and nothing more. If, for example, we particularize the spots and markings on the leaves and stems of herbaceous plants so commonly met with from early spring till the fall of the last leaf, and even amongst the dead and decaying remains of the vegetation of the year, we may include also such spots and marks as result from insect depredations or diseased tissue. It is not always easy, with a cursory observation under the microscope, to determine whether some appearances are produced by fungi, insects, or organic disease: experience is the safest guide, and until we acquire that we shall occasionally fail.

If we take a stroll away from the busy haunts of men, though only for a short distance,—say, for example (if from London), down to New Cross, and along the slopes of the railway cutting,—we shall be sure to find the plant called the goatsbeard in profusion. In May or June the leaves and unopened involucres of this plant will present a singular appearance, as if sprinkled with gold-dust, or rather, being deficient in lustre, seeming as though some fairy folk had scattered over them a shower of orange-coloured chrome or turmeric powder. Examine this singular phenomenon more closely, and the poetry about the pixies all vanishes; for the orange powder will be seen to have issued from the plant itself. A pocket lens or a Codrington reveals the secret of the mysterious dust. Hundreds of small orifices like little yellow cups, with a fringe of white teeth around their margins, will be seen thickly scattered over the under-surface of the leaves. These cups (called *peridia*) will appear to have burst through the epidermis of the leaf and elevated themselves above its surface, with the lower portion attached to the substratum beneath. In the interior of these cup-like excrescences or *peridia*, a quantity of the orange-coloured, sphœrical dust remains, whilst much of it has been shed and dispersed over the unoccupied portions of the leaves, the stems, and probably on the leaves of the grass or other plants growing in its immediate vicinity. These little cups are fungi,

the yellow dust the spores,* or ultimate representatives of seed, and the epiphytal plants we have here found we will accept as the type of the group or order to which we wish to direct attention (plate II. figs. 1—3).

Amongst the six families into which fungi are divided is one in which the spores are the principal feature, as is the aurantiaceous dust in the parasite of the goatsbeard. This family is named *Coniomycetes,* from two Greek words meaning "dust-fungi." This group or family includes several smaller groups termed orders, which are analogous to the natural orders of flowering plants. Without staying to enumerate the characteristics of these orders, we select one in which the spores are enclosed in a distinct peridium, as in our typical plant they are contained within the cups. This order is the *Æcidiacei,* so called after *Æcidium,* the largest and most important of the genera included within this order.

The *Æcidiacei* are always developed on living plants, sometimes on the flowers, fruit, petioles, or stems, but most commonly on the leaves: occasionally on the upper surface, but generally on the inferior. The different species are distributed over a wide area; many are found in Europe and North America, some occur in Asia, Africa, and Australia. When the cryptogamic plants of the world shall have been as widely examined and as well understood as the phanerogamic plants have been, we shall be in a better position to determine the geographical distribution of the different orders of fungi. In the present incomplete state of our knowledge, all such efforts will be unsatisfactory.

But to return to the goatsbeard, and its cluster cups. The little fungus is called *Æcidium tragopogonis,* the first being the name of the genus, and the last that of the species. Let us warn the young student against falling into the error of supposing because in this, and many other instances, the specific name of the fungus is derived from the plant, or one of the plants, upon which it is found, that therefore the species differs with that of the plant, and that, as a rule, he may anticipate meeting with a distinct species of fungus on every distinct species of plant, or that the parasite which he encounters on the living leaves of any one plant is *necessarily* specifically distinct from those found on all other plants. One species of *Æcidium,* for instance, may hitherto have been found only on one species of plant, whereas another *Æcidium* may have been found on five or six different species of plants. The mycologist will look to the specific differences in the

* Protospores, they should be called, because in fact they germinate, and on the threads thus produced the true spores, or fruit, are borne.

parasite without regard to the identity or distinctness of the plant upon which it is parasitic.

Before the *Æcidium* breaks through the epidermis the under-surface of the leaves of the goatsbeard will appear to be covered with little elevations or pustules, paler at the apex; these soon become ruptured, and the fungus pushes its head through the opening, at the same time bursting by radiating fissures. The teeth thus formed resemble those of the peristome of some mosses. All around the orifice of the peridium the teeth become recurved, and the orange spores are exposed, crowded together within. At first, and while contained within the peridium, these spores are concatenate or chained together, but when dispersed they are scattered singly about the orifice, often mixed with the colourless cells arising from the partial breaking up of the teeth of the peridium.

Let us pause for a moment in our examination of the individual cups, to ascertain their manner of distribution over the leaves. In this instance they are scattered without any apparent order over the under-surface, but generally thickest towards the summit of the leaves; occasionally a few are met with on the upper surface. Sometimes two or three touch at the margins, but we have never met with them truly confluent; generally there is a space greater than the width of the cups around each, the stratum or subiculum from whence they arise is scarcely thickened, and there are no spots or indications on the opposite surface. If a leaf be taken fresh and the cuticle stripped off, which it will sometimes do very readily, the orifices through which the *Æcidium* has burst will appear in irregular holes. If a section be made of one or two of the fungi *in situ*, they will be seen to spring from beneath the cuticle, the peridium to be simple, and rounded at the base, the spores clustered at the bottom, and the fringe to be a continuation of its cellular substance.

The spores in this species are orange, subglobose, sometimes angular, and indeed very variable both in size and form, though the majority are comparatively large. Each of these bodies is, doubtless, capable of reproducing its species, and if we compute 2,000 cluster-cups as occurring on each leaf, and we have found half as many more on an ordinary-sized leaf, and suppose each cup to contain 250,000 spores, which again is below the actual number, then we shall have not less than five hundred millions of reproductive bodies on one leaf of the goatsbeard to furnish a crop of parasites for the plants of the succeeding year. We must reckon by millions, and our figures and faculties fail in appreciating the myriads of spores which compose the orange dust produced upon one infected

cluster of plants of Tragopogon. Nor is this all, for our number represents only the actual protospores which are contained within the peridia; each of these on germination may produce not only one but many vegetative spores, which are exceedingly minute, and, individually, may be regarded as embryos of a fresh crop of cluster-cups. And this is not the only enemy of the kind which this unfortunate plant is subject to, for another fungus equally prolific often takes possession of the interior of the involucre wherein the young florets are hid, and converts the whole into a mass of purplish black spores even more minute than those of the *Æcidium*, and both these parasites will be occasionally found flourishing on the same plant at the same time (plate III. fig. 11).

Naturally enough, our reader will be debating within himself how these spores, which we have seen are shed in such profusion, can enter the tissues of the plants which give subsequent evidence of infection; in fact, how the yellow dust with which the goatsbeard of to-day is covered will inoculate the young plants of next year. If one or two of these spores are sprinkled upon the piece of the cuticle which we have recommended to be removed from the leaf for examination, it will be seen that they are very much larger than the stomata or breathing pores which stud the cuticle: hence it is clear that they cannot gain admittance there. There remains but one other portal to the interior of the plant—namely, the spongioles or extremities of the roots. Here another difficulty arises, for the spores are as large as the cells through which they have to pass. This difficulty may be lessened when we remember that what are termed the spores which are discharged from the cups are not the true spores, but bodies from which smaller seed-like vesicles are produced; yet, even then there will be much need of an active imagination to invent hypotheses to cover the innumerable difficulties which would encounter their passage through the vessels of the infected plants. The Rev. M. J. Berkeley proved many years ago that the spores of bunt, for example, may be caused to infect all the plants the seeds of which had been placed in contact with them; but this affection did not necessarily accrue from the absorption of the spores, or the ultimate spores produced after three or four generations. It is possible that the granular or fluid contents of the spores may be absorbed by the plant, and as a result of this absorption, become inoculated with the virus, which at length breaks out in fungoid growths. Much has been done to elucidate this mystery of inoculation, but much also remains a mystery still. There is no doubt that the inoculation takes place at an early age, probably in the seeds of many plants; in others it may be

conveyed with the moisture to the roots; but the spores themselves have certainly not yet been traced traversing the tissues of growing plants.

If, instead of going in search of goatsbeard and its attendant fungus, we turn our steps northward and enter one of the Highgate or Hampstead woods, where the pretty little wood anemone flourishes abundantly, and turn up the radical leaves, one by one, and examine their under-surfaces, we shall at length be rewarded by finding one covered with similar cluster-cups to those we have been describing as occurring on the goatsbeard, but far less commonly. Leaf after leaf will be found covered with the brown spots of another fungus called *Puccinia anemones*, with which nearly every plant will be more or less infected in the spring of the year; and at length, if we persevere, *Æcidium leucospermum* will be our reward (plate II. figs. 4—6). The specific name will suggest one point of difference between the two fungi, as in this instance the spores are white, and somewhat elliptic. Probably this species is not common, as we have found it but seldom, though often in search of it. A nearly allied species has been found on *Anemones* in gardens having but few large teeth about the orifice, though not constantly four as the name would indicate (*Æ. quadrifidum*).

A walk through almost any wood, in the spring of the year, will reward the mycologist with another *Æcidium* in which the peridia are scattered over the whole surface of the leaf. This will be found on the wood spurge, giving a sickly yellowish appearance to the leaves, on the under-surface of which it is found. By experience one may soon learn to suspect the occurrence of parasites of this nature on leaves, from the peculiar exhausted and unhealthy appearance which they assume as the spores ripen, and which will spare the labour of turning over the leaves when there are no distinct spots on the upper surface. *Æ. Euphorbiæ* is found on several species of *Euphorbium* or spurge, but we have always found it most abundantly on the wood spurge in the Kentish woods between Dartford and Gravesend. The spores in this species are orange, and externally it bears considerable resemblance to the goatsbeard *Æcidium*, but the spores are rather smaller and paler, the teeth are less distinct and persistent, the subiculum is more thickened, and the peridia are more densely crowded.

There is another group of species belonging to the same genus of fungi in which the arrangement of the peridia is different. One of the first of our native wild flowers in making its appearance after the departure of frost and snow, is the little yellow celandine.

"Ere a leaf is on the bush,
In the time before the thrush
Has a thought about her nest,
Thou wilt come with half a call,
Spreading out thy glossy breast
Like a careless Prodigal;
Telling tales about the sun
Where we've little warmth, or none."

And one of the earliest parasitic fungi in spring is an *Æcidium* which flourishes on its glossy leaves. So common is *Æcidium ranunculacearum* on this species of *Ranunculus*, that it can scarcely have escaped the eye of any one who has taken the trouble to examine the plant. It appears in patches on the under-surface of the leaves or on their petioles, in the latter case swelling and distorting them. Sometimes these patches are nearly circular, at others of very irregular form, and varying in size from less than one-twelfth of an inch to half an inch in diameter. It is found on several species of *Ranunculus*, as *R. acris*, *bulbosus*, and *repens*, but most commonly on *R. ficaria*. The leaf is thickened at the spot occupied by the parasite, and generally without indication on the opposite surface. Sometimes one spot, at others several, occur on the same leaf. The peridia are densely crowded together, often arranged in a circinate manner, *i.e.*, like a watch spring, or the young frond of a fern. The spores are orange, but slightly varying in tint on different species of *Ranunculus*. One of the smaller clusters, when collected before the spores are dispersed, or the teeth of the peridium discoloured, mounted dry as an opaque object, makes a very excellent slide for an inch or half-inch objective; and the same may be said of many others of the same genus (plate II. figs. 7—9).

Less common than the foregoing is the species of *Æcidium* which attacks the violet. The sweetest of flowers as well as the earliest, in despite both of its odour and its humility, becomes a victim to one or more of the ubiquitous race of fungi. Thickened spots at first appear on the leaves; the petioles, or flower stem, or even the calyx, becomes swollen and distorted; and at length the *Æcidium* breaks through. The spots on the leaves upon which the peridia are scattered are yellowish, generally larger than the clusters on the pilewort, and seldom with more than one spot on each leaf. The peridia, or cups, are irregularly distributed over the spots, not crowded together as in the last species; and the teeth are large, white, and distinct. The spores are at first orange, but at length become brownish. This species may be found in spring, as late as June, most commonly on the dog-violet, but also on other species of *Viola*.

It is not a very desirable occupation to search a bed of nettles, and turn over the individual leaves to look for minute fungi. A very pretty *Æcidium* is nevertheless far from uncommon in such a habitat. Fortunately it occurs very often on the petioles of the leaves and on the stem, distorting them very much; and in such situations flourishing, apparently, more vigorously than when occupying the under-surface of the leaves (fig. 10). In the latter situation the clusters of peridia are small, seldom exceeding a dozen in a spot, but several spots may be found on the same leaf. On the stem they are clustered around for upwards of an inch in length, and their bright orange colour in such a situation renders them very conspicuous objects. The peridia are always closely packed together upon a thickened base, and offer but slight variations from the forms already enumerated, save that they widen slightly at the mouth so as to become nearly campanulate. The spores are orange, and very profuse.

During the present summer we noticed, for the first time, a very pretty little species of *Æcidium*, on the wood sanicle in Darenth wood. It was far from uncommon, and we believe it to be specifically distinct from its nearest ally, found on the earthnut leaves, and those of some other umbelliferous plants. The little cups are in small clusters of four or five together, on the under-surface and on the petioles; they are small, but the teeth are relatively large, white, and distinct. The spores are of a pallid, yellowish colour, and not so profuse as in the last species. A darker spot on the upper surface of the leaf generally indicates their presence. This species was found many years ago by Carmichael at Appin, and called by him *Æcidium saniculæ*; but we find no notice of its occurrence since, though it seems to be far from uncommon at Darenth, and probably elsewhere should the sanicle be common also.

It is unnecessary here to refer to other allied species of *Æcidium*, except one to be presently noticed, since we have elsewhere enumerated and given descriptions of all the species hitherto found in Britain, together with figures of some not included here.* Suffice it to say that the one on the alder buckthorn has been very common this year in the Highgate and Hornsey woods. That on the honeysuckle we have found but very rarely. On the gooseberry and red-currant leaves commonly in some years and rarely in others; whilst a few of those described we have never collected. The species on different composite plants is subject to great variation, and on most may be found in the autumn; one variety only we have met with in the spring.

* In a forthcoming number of "Seemann's Journal of Botany."

Very few years ago farmers generally believed that the cluster-cups of the berberry were productive of mildew in corn grown near them; this opinion even received the support of Sir J. Banks, but no fungi can be much more distinct than those found on corn crops and this species on the leaves of the berberry. In this instance the cups are much elongated, and cylindrical, the clusters vary much in size, and the spots on the upper surface of the leaf are reddish, bright, and distinct. The teeth are white and brittle, and the orange spores copious (plate II. figs. 12—14).

There are scarcely any of the epiphyllous fungi forming equally handsome or interesting objects for low powers of the microscope, than the genus to which attention has been directed in this paper; and they possess the advantage of being readily found, for that locality must be poor indeed which cannot furnish six species during the year. We have found half of the number of described species within little more than walking distance of the metropolis, within a period of little more than three months, and should be glad to hear of the occurrence of any of the rest.

We have three species of fungi very similar in many respects to the foregoing, but differing in others to such an extent as to justify their association under a different genus and name. The hawthorn is a bush familiar to all who love the "merry month of May," but it may be that its parasite has been unnoticed by thousands. If, for the future, our readers will bear this subject in their minds when they stand beneath a hawthorn hedge, they may become acquainted with clusters of singular brown pustules on the leaves, petioles, and fruit well worthy of more minute examination (plate II. fig. 15). They scarcely claim the name of cups, and their lacerated and fringed margins rather resemble the pappus crowning the fruits of some composite plants than the cups of *Æcidium*. The peridia are very long, and split down throughout their length into threadlike filaments of attached cells; these gradually fall away and break up into their component cells till but short portions remain attached to the base of the peridia. These cells are elongated and marked on the surface with waved lines, forming in themselves pretty objects for a high power of the microscope (fig. 19). If the teeth of *Æcidium* resemble the peristome of some mosses, such as *Splachnum*, the threads of this species of *Raestelia*, except in not being twisted, somewhat resemble the peristomes of other mosses of the genus *Tortula*. The spores in this species are less conspicuous, being of a light brown, and the whole plant, from its modest hue, may be readily passed over without attracting attention unless occurring in abundance.

The leaves of pear-trees afford a second species of this genus sufficiently distinct to commend it to our notice. Sometimes it is very common, at others but few examples are to be met with. The clusters occur on the under-surface, and consist of half a dozen or less of large peridia, pointed at the apex and swelling in the middle so as to become urn-shaped. These vessels or thecæ split into numerous threads or laciniæ, which remain united together at the apex. Like the species already noticed, this is brown and inconspicuous except on account of its size, for it is the largest of all that we have had occasion to notice.

The third species occurs on the under-surface of the leaves of the mountain-ash. The peridia are clustered on a rusty orange-coloured spot which is visible on the upper surface. They are long and cylindrical, with an evident tendency to curvature, the mouth is serrated, but not split up into threads, as in the species found on the hawthorn. The peridia are often abortive, and nothing is to be seen but the rusty thickened spot on the leaf. The clusters and spores are of a brighter reddish brown than in either of the other species. All are remarkably distinct, and perhaps the most curious and interesting of any that we have passed in review. To botanists the species found on the hawthorn is known as *Rœstelia lacerata*, that on pear-leaves as *Rœstelia cancellata*, and the one on the leaves of the mountain-ash as *Rœstelia cornuta*.

Dr. Withering observed the spore-spots on the leaves of the mountain-ash, but was evidently puzzled to account for them. He writes (in his Arrangement of British Plants), "The spots on the leaves of *Sorbus aucuparia* consist of minute globules intermixed with wool-like fibres. On examining many of them in different states, I at length found a small maggot in some of the younger spots, so that the globules are probably its excrement, and the fibres, the woody fibres of the plant unfit for its food."

Only two species of cluster-cups are described in Withering's Flora under the genus *Lycoperdon:* one of these is now called *Æcidium compositarum*, and is found on various composite plants; the other includes the species found on the wood-anemone and that on the moschatel, and also probably a species of *Puccinia* on the wood-betony.

To render our paper more complete, though of less importance to the microscopist, we may allude to the other two genera comprised within this order. *Peridermium* is the name of one genus which contains two British species found on the leaves and young shoots of coniferous trees. In this genus the peridium bursts irregularly, and does not form cups or horns

or fringed vessels, with no compensating feature to recommend it to the microscopist.

In the genus *Endophyllum*, as its name implies, the peridium is imbedded within the substance of the succulent leaves. The only species we possess is found rarely upon the common houseleek.

We have derived much pleasure in viewing the astonishment and delight exhibited by friends to whom we have personally communicated specimens of the little fungi we have enumerated for examination under the microscope; and we recommend with confidence this group of parasitic plants, unfortunately so little known, as well worthy of the attention of all who are interested in the minute aspects of nature, and who can recognize the hand—

> "That sets a sun amidst the firmament,
> Or moulds a dew-drop, and lights up its gem."

CHAPTER II.

SPERMOGONES.

IN addition to their spore-bearing spots, lichens have for some time been known to possess other organs, termed *spermogones*, which are probably concerned more or less in the reproductive process. The first intimation of the existence of similar bodies in the entophytal fungi originated with M. Unger in 1833, but it was left to M. de Bary and the Messrs. Tulasne, twenty years later, to examine and determine satisfactorily the nature and value of the spermogones of the Uredines. It was at first believed that the smaller pustules—which sometimes precede, and sometimes accompany, the cluster-cups and some other allied fungi—were distinct species developed simultaneously therewith, or members of a new genus, which, under the name of *Æcidiolum exanthematum*, found a place in the mycologic system.

Without staying to trace the stages through which the elucidation of their true nature proceeded, it will suffice for our purpose to tell what is now known of these secondary organs; to accomplish which we must stand greatly indebted to the independent researches of Messrs. De Bary and Tulasne. It has been demonstrated that both these bodies, namely, the primary organs or cluster-cups, and the secondary

organs or spermogones, are developed from the same mycelium; but the value of the latter is still undetermined. If they possess any fecundative power, the process has not been traced; or if they are in themselves reproductive, they have not at present been seen to germinate. Their uses, therefore, in the economy of the parasitic plant of which they are now known to form a part is still a mystery, and they remain valueless in the determination of genera and species. Any speculation which might regard them as male organs would be premature, and without support in fact. Hitherto only some species of the genera described in the foregoing chapter, and others belonging to genera not hitherto named, have been ascertained to possess spermogones. Of the former are the *Rœstelia* of pear leaves, some species of *Æcidium*, as those of *Euphorbia*, &c., and *Peridermium Pini*.

These spermogones are of a very simple structure—very delicate, indeed; so much so, that they will scarcely bear preparation for demonstration. De Bary states that they originate from plain, delicate, inarticulate threads, about half the thickness of the mycelium (the root-like branching fibres which form the fundamental stratum of fungoid growths), which are developed in large quantities, and closely packed together. These threads are compacted together so as to form an outer enveloping integument or peridium, which is either globular or hemispherical (or in some instances elongated), more or less immersed, and at length opening at the apex by a regularly formed minute ostiolum. The inner wall of the peridium is covered with a thick forest of simple filaments standing on end. From the summit of these filaments or sterigmata, the spermatia are borne. These are either isolated or associated together in strings or chaplets, are exceedingly minute, of an ovoid or oblong shape, and are produced in such numbers as to fill the cavity of the spermogone. Besides these, a viscid fluid is secreted, in which the spermatia are immersed, and which is expelled with them from the orifice of the peridium. According to the density of this fluid, or the hygrometric state of the atmosphere, it appears sometimes in drops, and sometimes oozing out in threads or cirrhi from the spermogones. To compare minute things with gigantic, as a recent author has observed, it resembles the lava issuing from the crater of a volcano. The colour of this spermatiferous matter is commonly orange, but in some instances brown, though not constantly of the same colour as the spores produced from the same mycelium. This gelatinous substance is dissolved away from the granular bodies which are immersed in it, by adding a little water upon the slide on which the mass is placed for examination. The granules, or spermatia,

then exhibit those peculiar movements which have been observed in the similar bodies in lichens, and fitly described as "a sort of oscillating motion, as of a body attached at one extremity." The cause of this motion is at present uncertain, vibratile ciliæ, to which similar movements are referred, being altogether absent; but probably, as De Bary believes, the cause may be found in the influence of exosmose.

Fig. 1. Fig. 2.

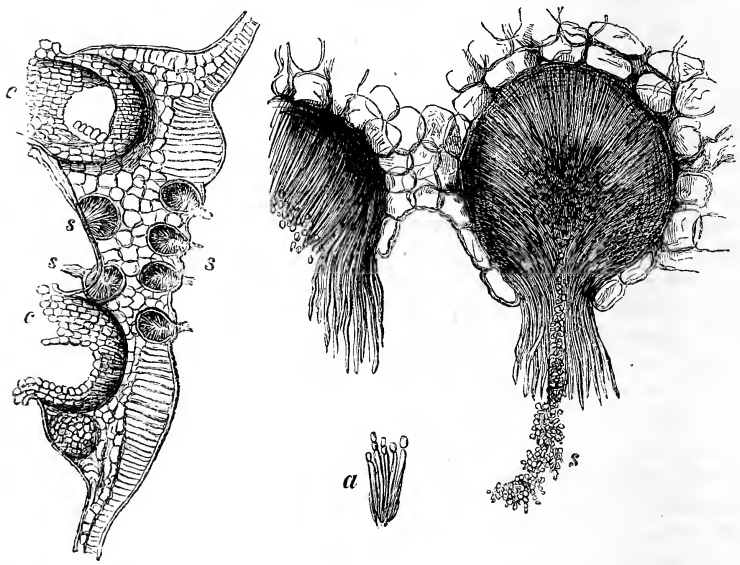


Fig. 1. *Æcidium grossulariæ.* *c.* Cluster-cups. *s.* Spermogones.
„ 2. Section of ripe spermogones of *Æcidium Euphorbiæ.* *s.* Spermatia. *a.* Sterigmatæ bearing spermatia (*De Bary*).

The largest spermatia yet examined (those of *Peridermium Pini*) have a length equal to $\frac{1}{2500}$ of an inch, but their width seldom exceeds $\frac{1}{100000}$ of an inch, whilst in others their length does not exceed the width of those just named.

Messrs. Tulasne affirm that all these corpuscles, as well as the mucilaginous fluid, evolve an appreciable odour, resembling that of the pollen of the willow. M. Léveillé compares the odour to that of orange flowers, and M. De Bary to that of the evening primrose.

The spermogones do not always appear like pustules on the surface of the leaves, for sometimes their presence is only indicated by minute depressed punctures which are scarcely visible; generally, however, they may be recognised by an

obtuse, or otherwise a pointed, protuberance that surmounts them. The margin of the orifice is sometimes furnished with short hairs, but is more frequently ornamented with a pencil of long hairs, which are stiff and erect, and of the colour of the enclosed spermatia.

In many of the species of *Æcidium* the cups are disposed in a more or less regular circle, the centre of which is occupied by a group of spermogones; at the same time, the corresponding spot on the opposite surface of the leaf will frequently be found also occupied by other spermogones—in some instances in greater number than on the same surface of the leaf on which the cups are seated. This is the case in the *Æcidium* which is found upon the leaves of the coltsfoot, and that of the honeysuckle.

Very bright orange-coloured spots may be observed in autumn (we encountered them several times last month) upon the leaves of pear trees, and which are covered with little tubercles, at first of the same colour, but ultimately becoming brown. These pustules are so many spermogones belonging to *Rœstelia cancellata*, a kind of cluster-cup found in the same localities. These spots have long since been noticed, and regarded as connected with the *Rœstelia*, but in what manner has until recently been unknown. The Rev. M. J. Berkeley noticed them in the English Flora in 1836, or at least the granulations on the upper surfaces of the leaves bearing *R. cancellata*, *R. cornuta*, and *R. lacerata*, and called them abortive pseudoperidia. Before this (in 1804) they had been observed by Rebentisch. An examination of one of these spots under a low power of the microscope, and afterwards a section of one or more of the pustules, cut with a sharp razor, and viewed with a higher power will give an idea of the nature of the bodies we are attempting to describe. During the past summer we have noticed very similar orange spots on leaves of the berberry containing spermogones on both surfaces, and these appeared before any cups had been found on that plant. In this instance no cups were produced from the spots on the leaves examined, and which were carefully noticed at intervals until they withered and fell.

In some instances, as in *Rœstelia cornuta*, which is found on the leaves of the mountain ash, the cups are produced on the lower, but the spermogones almost exclusively on the upper surface.

The spermogones of *Peridermium Pini* are white, few in number, and are developed, not only in the spring, but sometimes reappear in the autumn upon the same leaves that produced them at the commencement of the year.

In such instances as those of the *Æcidium* of the spurge,

and also the goatsbeard, in which the cluster-cups are arranged in no appreciable order, the spermogones are scattered amongst them, and even in some instances appear on different leaves. The spermogones are common on the wood spurge in spring, scattered over both surfaces of the leaves before the cluster-cups make their appearance, and gradually these latter are developed amongst them, commencing from the apex of the leaves and proceeding in the order of their development towards the base. In this instance the spermogones are bright yellow, as are afterwards the cups and spores of the *Æcidium*. In most instances the appearance of the spermogones precedes that of the sporiferous organs, but the latter follow sufficiently speedy for perfect development before the decadence of the spermogones takes place.

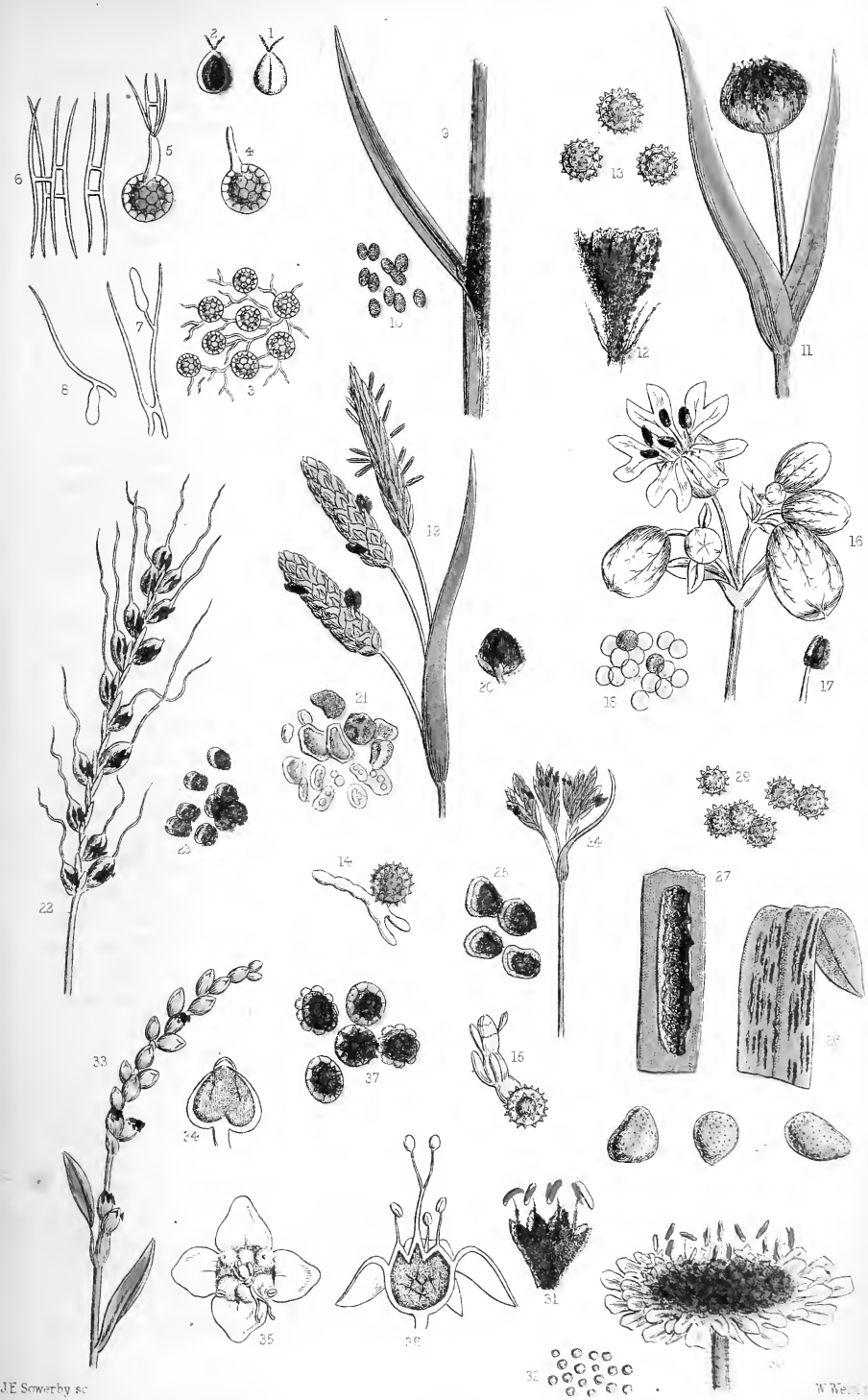
After the expulsion of the spermatia and the fluid which accompanies them, the whole mass dries up; and where many spermogones have been clustered together in the same spot a brown homogeneous crust is formed upon the epidermis; where they are produced singly, a brownish incrustation is visible about the mouth of each spermogone.

Re-agents applied to the spermogones whilst in full vitality indicate the presence of a considerable amount of a protein substance, which, with sugar and sulphuric acid, produces a deep purple red colour.

From what we have already stated of the method of occurrence of these organs, the following is the only order, apparently, preserved in their development, although no definite rules can at present be affirmed. The spore-spots or cluster-cups are generally found upon the under surfaces of the leaves on which they are produced, and the spermogones are most numerous on the upper. When both the cluster-cups and the spermogones appear in the same group on the same surface, the spermogones commonly occupy the centre, and the cups are arranged in a circular manner about them. In other, and fewer instances, both organs stand together indiscriminately upon the same surface.

The spermogones are also developed centrifugally, at least so far as at present observed, for when they are produced in a cluster the central one first opens and discharges its contents, and thus the development proceeds outwards from the centre to the circumference. When the spermogones are scattered, as in those of *Euphorbia*, they are first observed at the apex of the leaf, whence they are developed in succession towards the base. The latter should be sought for on the young plants of the wood-spurge in March or April, at which time we have found them abundant at Darenth wood, near Dartford.

It must not be concluded, from the fact that we have not



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Smuts

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yet adverted to spermogones in connection with other fungi, that they are peculiar to the *Æcidiacei*. Such is by no means the case. It would scarcely convey any information to our readers if we were now to enumerate other genera and species in which spermogones occur, without describing the fungi with which they are associated. This would be out of place, inasmuch as we hope at a future time to treat, in detail, of these unnoticed genera. Let it suffice therefore that we state that they have been found in members of the genera, *Aregma*, *Triphragmium*, *Puccinia*, *Lecythea*, *Trichobasis*, and *Uredo*, but they have been found much more generally in *Rœstelia* and *Æcidium* than in any other genus.

As comparatively little is yet known of these bodies, a fair field is open to the enterprising microscopist, with time at his disposal, and a good store of perseverance, to win for himself renown in the discovery of fresh facts, and the elucidation of some of the mysteries which yet enshroud these interesting organisms. From the foregoing pages he will learn the direction in which his researches should tend, and he may be assured that every new fact is of importance when carefully ascertained.

CHAPTER III.

SMUTS AND BUNT.

ONE of the fungal diseases of corn long and widely known has obtained amongst agriculturalists different appellations in different localities. In some it is the "smut," in others it is respectively "dust-brand," "bunt-ear," "black-ball," and "chimney-sweeper," all referring, more or less, to the blackish soot-like dust with which the infected and abortive ears are covered. This fungus does not generally excite so much concern amongst farmers as the other affections to which their corn crops are liable. Perhaps it is not really so extensively injurious, although it entirely destroys every ear of corn upon which it establishes itself. Wheat, barley, oats, rye, and many grasses are subject to its attacks, and farmers have been heard to declare that they like to see a little of it, because its presence proves the general excellence of the whole crop. No one who has passed through a field of standing corn, after its greenness has passed away, but before it is fully ripe, can have failed to notice, here and there, a spare, lean-looking ear, completely blackened with a coating

of minute dust. If he has been guilty of brushing in amongst the corn, it will still be remembered how his hands and clothing became dusted with this powder; and if at the time he should have been clad in sombre black, evidence will have been afforded—in the rusty-looking tint of the powder when sprinkled upon his black continuations—that, however sooty this powder might appear whilst still adhering to the ears of corn, it has an evident brown tint when in contact with one's clothes. This powder, minute as it is, every granule of it constitutes a spore or protospore capable of germination, and ultimately, after several intermediate stages, of reproducing a fungus like the parent of which it formed a part. During the growth of the plant its virulent contents flow like a poison through the innermost tissues, and at length attack the peduncle or axis of the spikelets of the ear, raising up the essential organs and reducing them to a rudimentary state. Brongniart, who made this species the special subject of observation, states that the fleshy mass which is occupied by the fungus consists entirely of uniform tissue, presenting large almost quadrilateral cavities, separated by walls, composed of one or two layers of very small cells filled with a compact homogeneous mass of very minute granules, perfectly spherical and equal, slightly adhering to each other, and at first green, afterwards free or simply conglomerate towards the centre of each mass, and of a pale rufous hue; at length the cellular walls disappear, the globules become completely insulated, and the whole mass is changed into a heap of powder, consisting of very regular globules, perfectly alike, black, and just like the reproductive bodies of other fungi. A scientific botanist of some repute, M. Unger, published a work in Vienna during the year 1823, in which he sought to prove that this, and allied species of fungi, were not fungi at all, but merely broken up cells, or disruptured and altered conditions of certain portions of the diseased plants. The most satisfactory refutation of this theory may be found in the fact that the spores of the smut can be seen to germinate under favourable conditions and produce fruit, whereas if they were only the ordinary cells of the plant broken up by disease, fructification would not take place.

The spores in this species are exceedingly minute. It has been ascertained that forty-nine of them would be contained within a space the one-hundred-and-sixty-thousandth part of a square inch, hence one square inch of surface would contain little less than eight millions. These myriads of spores are shed from the ears, and nothing remains but the barren matrix in which they were borne when the farmer proceeds to gather in his crops. At that time he sees no more of the "smut," all

remembrance of it for the time is gone, his only thought is to stack his corn in good condition. But the millions of spores are dispersed, ten millions at least for every ear that has been "smutted,"—and will they not many of them reappear next year, and thus year after year, with as much certainty as the grain upon which they are parasitic?

Like many of the parasitic fungi, so destructive in the farm and the garden, this species belongs to the family in which the spores are the distinctive feature. After many botanical changes, the "smut" is at length regarded as a fixed resident in the genus *Ustilago* with the specific name of *segetum*, which latter signifies "standing corn;" it is therefore the *Ustilago*, or *smut of the standing corn*. The characters of the genus are chiefly that the spores are simple and deeply seated, springing from delicate threads, or in closely packed cells, ultimately breaking up into a powdery mass. Fifteen members of this genus have been described as British. One of these (*U. maydis*) attacks the maize or Indian corn grown in this country in a similar manner as the common smut attacks wheat or barley; but as maize is not an established crop with us, a more minute description of this species is unnecessary; the spores are figured in plate III. fig. 29. Another species (*U. hypodytes*) makes its appearance at first beneath the sheaths of the leaves surrounding the stems of grasses, and ultimately appears above and around them as a purplish-black dust. The seeds of sedges, the leaves and stems of certain definite species of grass, the flowers of scabious, the receptacles of the goatsbeard, the anthers of the bladder campion, and other allied plants, and the seeds of the Bistort family, are all liable, more or less, to the attacks of one or other of the residue of the fifteen species of *Ustilago* already referred to as indigenous to Britain.

Although we do not profess to teach practical men how to grow good corn, or how they shall get rid of, or keep clear from, the many foes to which their crops are exposed, yet a suggestion may be offered, based upon the facts obtained in our botanical researches, supported by the analogy of allied circumstances. In this instance the extreme minuteness and profusion of the spores would evidently render all the corn liable to the attachment of, perhaps only two or three, spores to the seed coat. Some ears of corn in nearer proximity to the smutted ears may be covered with spores which yet remain invisible to the naked eye, and when these grains are mixed with others in the heap, the chances are not much in favour of any handful not becoming charged with spores. If the majority of these were not redeemed from destruction by the many changes, shiftings, rubbings, and scrubbings to

which the seed corn is liable between the time of its reaping and the period of its sowing, we might expect a very large crop of "smutted" corn. Under ordinary circumstances we can scarcely imagine that the loss arising from infected ears would repay much special labour to prevent it, only that to a large extent the precautions taken to cleanse the seed corn from the spores of one fungus will also avail for another, and while cleaning it of the spores of "smut," those of "bunt" will also be removed. The facts that we rely upon chiefly as indicating the remedy are that the spores are only superficially in contact with the seed corn, and that they are of less specific gravity, causing them to float on the surface of any fluid in which the corn may be immersed. Again, the spores of many species of fungi will not germinate after saturation with certain chemical solutions. One of the most successful and easy of application is a strong solution of Glauber's salt, in which the seed corn is to be washed and afterwards, whilst still moist, dusted over with quick-lime. The rationale of this process consists in the setting free of caustic soda by the sulphuric acid of the Glauber's salt combining with the lime, and converting it into sulphate of lime. The caustic soda is fatal to the germination of the spores of "bunt," and probably also of "smut;" although, as already intimated, except in cases where these affections of the corn are very prevalent, we shall be informed by the agriculturist that the cost of labour in the prevention will not be compensated in the cure.

Experience has also taught us that all fungi flourish in proportion to the wetness of the season, or dampness of the locality. A wet year is always exceedingly prolific in fungi, and a dry season correspondingly barren. In a field or a wood the mycologist reaps his richest harvest of mycological specimens in the lowest and dampest spots, in swamps, ditches, and ill-drained nooks. This is a fact worth knowing as much by the farmer as the amateur botanist in search of specimens for his herbarium.

One of the most unmistakable species of "smut" is that which infests the goatsbeard, on which we have already described an *Æcidium*. Generally about the same time as the cluster-cups make their appearance on the leaves, some of the unopened flower-heads of this plant will be found considerably altered in appearance by the shortening of the segments of the involucre, and at length by the whole inflorescence being invested with a copious purplish-black dust. If, by any means, the lobes of the involucre are any of them separated, the enclosed dust escapes, blackening the fingers and clothing of the collector, as if it were soot. A little of

this dust submitted to the microscope will be found to consist of myriads of small globose spores, nearly uniform in size and shape; and if a high power be employed, each of these will appear to have a papillose or minutely granulated surface. The florets, dwarfed in size and contorted, or the remains of them, are embedded in the mass of spores, and if one or two of these are removed and placed under a good one-inch objective, every part will be found covered with adhering spores, to the apparent exhaustion of its substance. Of course, the florets are never developed when subjected to the attack of "smut." The whole plant assumes a faded, sickly appearance, even before the spores are fully ripened. We would recommend our readers, if they collect one of the infected flower-heads, to put it into a box or paper by itself, for if placed in the box with other specimens it will so sprinkle them with its black powder as to render them nearly useless for microscopic examination: everywhere the microscope will detect, where the unaided eye failed to recognize a trace, the ubiquitous spores of *Ustilago receptaculorum* (plate III. figs. 11—15).

In the fenny districts of the eastern counties a species of "smut" called *Ustilago typhoides* attacks the stems of reeds, forming thick swollen patches of several inches in length, sometimes occupying the whole space between two joints or nodes, and lying beneath the sheath of the leaves. The spores in this species are larger than in the species which attacks the culms of grasses in a similar manner, and which we have figured under the name of *Ustilago hypodytes* (plate III. figs. 9, 10).

There are not many features in the rest of the species of this genus of sufficient interest to the general reader or microscopist to render it advisable to furnish any detailed account of them. We may, however, note that in a species found but rarely on the leaves of the common cocksfoot-grass the spores are large, obovate, and rough with minute granules. The spores of *Ustilago utriculosa*, found on different species of *Polygonum*, instead of being granulated are reticulated on the surface (plate III. figs. 33—37). The chief interest attaching to *Ustilago antherarum* consists in its habitat, for it is developed in the anthers of the flowers of the bladder campion, and other plants of the same natural order. The anthers are much swollen and distorted by this parasite, which is not uncommon, though easily overlooked unless specially sought after (plate III. figs. 16—18. A list of all the British species will be found at the close of this paper. It will be noted that as in the genus *Æcidium* the prevailing colour of the spores is orange, so in the genus *Ustilago* it is black, with a purplish or violaceous tinge.

Four diseases in wheat of fungal origin are known and recognized by agriculturists; these are called in the popular language of the farm, "mildew," "rust," "smut," and "bunt." Sometimes one and sometimes another is most prevalent, and he is an exceedingly fortunate individual who can walk through his fields and find only one of them, especially if that one should be sparingly distributed. It has been our good fortune to dwell much amongst cornfields, and the terror of the word "mildew" to a farmer's ears is not unfamiliar in our reminiscences of the past, ere we discarded the much-loved country to become a dweller in town. The subject of our present remarks inspired no such alarm in the districts of our experience, but in some seasons and localities it is certainly one of the "pests of the farm." Under the different appellations of "bunt," "pepper brand," "bladder brand," and sometimes "smut," this infection is very generally known. Externally there is no appearance, except to the practised eye, that anything is wrong. There is no black impalpable dust about the ears as in the true "smut," no red withered leaves or spotted stem as in the "rust" and "mildew," and no stunted growth or malformation, evident to the casual glance, by which the insidious foe can be recognized; but stealthily and secretly the work is accomplished, and until the "bunted" grains make their appearance in the sample, the disease may, perchance, be unchallenged.

Externally the "bunted" grain is plumper, and whilst the corn is still green these will be of a brighter green than the rest. When broken, the farinaceous interior will be found replaced by a minute black dust of a very fœtid, unpleasant odour, and greasy to the touch. This powder constitutes the spores of the "bunt" mixed with myceloid threads. It may happen that much of the corn in a field is "bunted" and the discovery not made till the wheat is being ground for flour; then the odour and colour will speedily decide the produce to be unfit for human food. We have not the least doubt that "bunted" corn, when ground with flour, is injurious in proportion to its extent, whilst at the same time we can scarcely conceive an intelligent miller grinding up a sample containing any large proportion of "bunted" grains in ignorance of the fact.

If we break open a grain of wheat infested with the "stinking rust" or "bunt," and then place some of the powder in a drop of water on a glass slide, and submit this to the microscope, first using the half-inch power, then the quarter, or fifth, and finally an eighth or tenth, we shall find that this minute dust consists of myriads of globose brown bodies, termed spores, which possess certain reproductive func-

tions. These spores will be found mixed with a number of delicate branched threads, to which they are attached by a short stalk or pedicel, visible with the higher powers. The surface of the spores you will also observe to be beautifully reticulated. These features just described as visible in the "bunt" are the characteristics of the genus to which it belongs (*Tilletia*), and of which it is the only British species. An allied species infests the Sorghum or durra, a grain but little cultivated in Europe, but found extensively in Africa and Asia, and also the *Bajra* of India.

The interesting experiments of the Rev. M. J. Berkeley on the germination of "bunt" spores have been already alluded to. They were undertaken shortly after the outbreak of the potato disease, to ascertain, if possible, the mode by which the minute spores of fungi inoculate growing plants; and although at that time only a bare suspicion of the nature of the bodies resulting from the germination of "bunt" spores was entertained, succeeding examinations in the same direction have brought to light extraordinary facts, and manifested the progress of the successive developments of four generations. The spores of "bunt" are larger than those of the different species of "smut," and reticulated on the surface. When these are made to germinate a kind of stem is protruded upon which small clusters of elongated thread-like spores of the second generation are produced (plate III. fig. 5). After a time these spores conjugate, or become united by short transverse processes in the same manner as has been observed in some of the lower forms of Algæ (plate III. fig. 6). The conjugated spores in the next stage germinate and produce a third kind of fruit different from either of the preceding, and constituting a third generation of spores (fig. 7). These in turn produce a fourth order of spores, so that in the process of growth the "bunt" spores evidently pass through four generations. Hence, as one result the number of germinating bodies is greatly increased, as well as their power of inflicting injury in a corresponding diminution in size. There are still many points in the history of the growth and development through successive generations of the "bunt" spores, but enough is known, on the one hand, to show that this is a true vegetative parasite, and not merely a diseased condition of the tissues of the wheat plant, and on the other that it is perfectly distinct from all the phases of the other and similar parasitic fungi which affect the wheat crop.

In the course of the preceding pages we have endeavoured to illustrate two groups of Coniomycetal fungi. The first of these containing four allied genera, in all of which a distinct peridium is present, *i.e.* :—

Ræstelia, in which the elongated peridium separates in threads which are either united at their apices or free.

Peridermium, in which the elongated peridium ruptures irregularly.

Æcidium, in which the peridium opens by reflexed teeth.

Endophyllum, in which the peridium is immersed in the substance of the leaf.

The second group contains two allied genera, *i.e.* :—

Ustilago, in which the simple spores are produced as closely packed cells, and ultimately break up into a powdery mass.

Tilletia, in which the reticulated spores spring from delicate branched threads.

The members of the first group are associated together in one natural order termed *Æcidiacei*. Those of the second group form a portion of another natural order called *Pucciniei*, to which we shall have occasion to return in the next number.

TILLETIA. *Tulasne.*

Spores sphærical, reticulated, proceeding from delicate branched threads.

Tilletia caries. *Tul.* (Bunt.) In wheat-grains. Autumn. Common.

Plate III.—Fig. 1. Infected grain.—2. Section of same.—3. Spores magnified 320 diameters.—4. Spores germinating, magnified 460 diameters.—5. Ditto, producing elongated spores.—6. Conjugating spores.—7. Elongating spores producing fruit of the third order.—8. Spore of third order germinating.

USTILAGO. *Link.*

Plant deeply seated. Spores simple, springing from delicate threads, or in closely packed cells, breaking up into a powdery mass.

Ustilago Segetum. *Ditm.* (Corn smut.) On ears of corn and grass. Autumn. Very common.

Fig. 22. Ear of smutted barley.—23. Spores magnified 460 diameters.

Ustilago urceolorum. *Tul.* (Sedge smut.) On the seeds of *Carices*. Autumn. Not uncommon.

Fig. 19. *Carex recurva* infected with smut.—20. Smutted fruit.—21. Spores magnified 460 diameters.

Ustilago longissima. *Tul.* (Elongated smut.) On leaves of *Poa aquatica*. Summer. Common.

Fig. 26. Portion of infected leaf.—27. Spore-spot magnified 60 diameters.—28. Spores magnified 460 diameters.

Ustilago olivacea. *Tul.* (Olive smut). On *Carex riparia*. Not common.

Ustilago hypodytes. *Fr.* (Grass-culm smut.) On culms of grass. Summer. Sometimes not uncommon.

Fig. 9. Infected stem of grass.—10. Spores magnified 460 diameters.

USTILAGO MAYDIS. *Corda.* (Maize smut.) On stems, &c., of maize.

Fig. 29. Spores magnified 460 diameters.

USTILAGO MONTAGNEI. *Tul.* (Beaksedge smut.) On seeds of *Rhyncospora alba.* Not common.

Fig. 24. Infected plant.—25. Spores magnified 460 diameters.

USTILAGO TYPHOIDES. *B. and Br.* (Reed smut.) On stems of the common reed. Autumn. Not uncommon.

USTILAGO SALVEII. *B. and Br.* (Cocksfoot smut.) On leaves of cocksfoot grass. Not common.

USTILAGO GRAMMICA. *B. and Br.* (Banded smut.) On stems of *Aira aquatica.* Not common.

USTILAGO VINOSA. *Tul.* (Oxyria smut.) On receptacles of *Oxyria reniformis.* Uncommon.

USTILAGO UTRICULOSA. *Tul.* (Utricle smut.) On utricles of various species of *Polygonum.* Autumn. Not uncommon.

Fig. 33. Portion of infected plant of *P. hydropiper.*—34. Section of smutted utricle.—37. Spores magnified 460 diameters.—35. Infected flower of *P. persicaria* magnified.—36. Ditto section. (*Tulasne.*)

USTILAGO FLOSCULORUM. *Fr.* (Floret smut.) On the florets of scabious. Not common.

Fig. 30. Infected flower-head of field scabious.—31. Central floret infected.—32. Spores magnified 460 diameters.

USTILAGO RECEPTACULORUM. *Fr.* (Goatsbeard smut.) On the receptacles of goatsbeard. June and July. Common.

Fig. 11. Infected receptacle of goatsbeard.—12. Distorted floret magnified.—13. Spores magnified 460 diameters.—14, 15. Germinating spores (*Tulasne*) magnified 460 diameters.

USTILAGO ANTHERARUM. *Fr.* (Anther smut.) On the anthers of bladder campion, &c.

Fig. 16. Infected flower.—17. Swollen anther.—18. Spores magnified 460 diameters.

EXPLANATION OF PLATE II.

Fig. 1. Goatsbeard cluster-cups (*Æcidium tragopogonis*) on portion of plant.
„ 2. Cups enlarged.—3. Section magnified.
„ 4. White-spored cluster-cups (*Æ. leucospermum*) on leaf of wood-anemone.
„ 5. Portion enlarged.—6. Cups magnified.
„ 7. Ranunculus cluster-cups (*Æ. ranunculacearum*) on leaf of pilewort.—8. A cluster enlarged.
„ 9. Section of cups.
„ 10. Nettle cluster-cups (*Æ. Urticæ*) on nettle stem.—11. Cups enlarged.
„ 12. Berberry cluster-cups (*Æ. Berberidis*) on leaf of berberry.—13. Portion of a cluster enlarged.—14. Cups magnified.
„ 15. Hawthorn cluster-cups (*Ræstelia lacerata*) on leaf and fruit of hawthorn.—16. Portion enlarged. 17. Section of cups.—18. Cells of peridium magnified 250 diameters.—19. Single cell further magnified.

PLATE III. Embodied in description of species.

ON THE PHYSICAL GEOGRAPHY OF THE IONIAN ISLANDS.

BY PROFESSOR D. T. ANSTED, M.A., F.R.S.

Part II.

IN a previous article I have spoken of the undrained valleys of Corfu, the curious salt-water millstreams of Cephalonia, and the remarkable weathering of detached blocks of limestone in several of the islands of the Ionian group, as among the many striking illustrations of their physical geography that attract the attention of the scientific traveller. These all have reference to the state of the limestone rock of which a large proportion of all the islands is composed. Limestone forms the ridges of the mountains, appears in innumerable broken fragments on the summits and sides of the hills, and may be found at no great depth underneath the soil of the plains. The islands are perfect studies of limestone, and chiefly in that form —half chalky, pure, but hard and very brittle—that is most subject to the action of water. Water dissolves it readily and wears it rapidly. It is full of cracks and crevices of all sizes; caverns and fissures are formed in it with extreme rapidity, and when formed, their sides and roofs often fall in and admit of a more free and rapid action of the water than before. There is thus a perpetual change going on.

But limestone,—that is, common carbonate of lime,—is not the only rock. Invarious places in all the islands, but especially in the north-west of Corfu (perhaps also in the southern extremity, which I was unable to visit), in the west of Cephalonia, and the south-east of Zante, the ordinary carbonate of lime is largely replaced by the sulphate, the rock consisting chiefly of gypsum, capable of being used for the manufacture of plaster, but not in fine veins of alabaster. Both in the neighbourhood of this rock and elsewhere there are springs yielding sulphuretted hydrogen gas. The condition of the rock, and the probability that a considerable tract of lava underlies the whole series of comparatively modern limestone in this part of the Mediterranean, render it probable that these gypsums and mineral springs are due to the action of vapourized sulphur rising from solfataras in crevices of the lava. The

gypsums are always accompanied by a large quantity of soft marl, which greatly influences the physical features of the country, giving it a character often highly grotesque. This is well seen near Lixuri in Cephalonia. There are also characteristic marks of it in the hill behind Zante and at Mount Scopos, in the same island.

The natural drainage of the islands is, of course, greatly influenced by this peculiar condition of the rocks of which they are formed. The islands consisting of granite, slate, or compact sandstone, or even of clay, a very large proportion of the water that falls as rain from the clouds runs down the hill sides in brooks or rivulets, traverses the plains, collecting other streams as it goes, and at length forms rivers proportioned to the extent of the land and length of the course. These rivers pour a tributary stream into the ocean. Nothing of this kind is seen in the Ionian Islands. Notwithstanding the height and extent of the mountains in the larger islands, and the high hills in those of smaller size—notwithstanding the occasional heavy rain that falls, and the large quantity of water that thus comes upon the ground, as is indeed evident by the marks of torrents that seam the mountain sides, there are no streams worthy the name of rivers in any of the islands. In Corfu, whose area is 227 square miles, and whose mountains are nearly 3,000 feet high, there are but two small streams entering the sea, and only one of these is large enough to require a bridge. In Cephalonia, whose area is 311 square miles, there is no river deserving of the name, and very few places where there is any constant run of water into the ocean. The stream that drains the extensive valley between the lofty and generally snow-covered range of the Black Mountains and the lower but not inconsiderable coast range to the west, almost disappears before it enters the Gulf of Samos, and no other stream is worth mentioning. Zante, with its 160 square miles of surface and semicircle of mountain on the west coast, has no river at all. Santa Maura, of the same area, is almost equally without streams, although it has a central ridge and two parallel coast ridges, offering the most favourable conditions for streams. Ithaca has nothing that could not be stepped across. This total absence of streams, beyond the merest indications of a mountain-torrent only carrying down water immediately after heavy rains, is a striking feature in the physical geography of the Ionian Islands. It contrasts strongly with what is seen generally in Europe, and it has great bearing on the fertility of the islands, on the nature of the crops grown on them, their sanitary condition, and on their human inhabitants. It is difficult to overestimate the influence of these conditions of natural drainage on the various lands subject to them.

But if the rainfall in the Ionian Islands is, as we have reason to suppose, rather large in proportion to that of the adjacent countries, and the natural channels for carrying off the water to the sea are so small and few, it becomes an interesting and important question to consider the cause of conditions so anomalous. This has already been alluded to in speaking of the highly-cavernous state of the limestone. Just as in various parts of the Mendips there are swallow holes in which the streams of the neighbourhood are swallowed up and made to disappear, so in almost every valley of all the Ionian Islands there is something of the same kind. In the Mendips, indeed, these swallowed-up rivers reappear in springs at the foot of the cliff in the valley below, and form streams once more, whereas in the Ionian Islands they are altogether lost sight of, the water being all carried away by evaporation from the general surface of the country during the long and fierce heats of summer. This difference, however, is one of little importance, and does not diminish the value of the explanation. All the rain sinks into the earth and is dispersed far and wide during the wet season, and during droughts the water is brought again to the surface by evaporation. Thus, in spite of great dryness and no soil, there is a cultivation of the vine in some places among the bare stones lying upon the naked limestone rock.

The removal of forests which at one time seem to have covered large tracts of country in several of the islands has probably produced much effect on the general climate, but especially on the rainfall, and on the distribution of the rain after it has fallen. The trees were, for the most part, evergreen oaks or pines, preventing, or at least greatly checking, evaporation during summer, and acting, as trees always seem to do, in increasing the rainfall in the rainy season, and increasing the total number of days on which rain falls. It would seem that the very large human population formerly living on the islands existed at a time when these forests had not been removed; and it is very possible that a tree vegetation, of slow growth, and of which the leaves do not fall till spring, may be far less injurious in malarious districts than a surface generally bare, but covered very quickly after the winter and early spring rains with a luxurious growth which again dies away and is burnt by the hot summer sun. Certain it is that the climate, in many parts of all the islands, except perhaps Ithaca, is now eminently malarious, and that the population increases very much less rapidly than should be the case in a well-governed country with no political drawbacks.

In all the islands there is some kind of wet season, commencing in November and lasting at intervals till April. About

the time of each equinox there is the usual excess of wind and rain. After the autumnal equinox there is generally a longish interval of fine weather before the winter rains set in, and after the vernal equinox there are also six weeks of fine weather. Following the former interval towards Christmas is a season during which heavy rains fall continually, while following the latter interval in June there is only a very short season of rain, and then fair weather and dry air till the end of September. The climates are, however, less certain than in the adjacent main lands, and long droughts occasionally take place in the beginning of the year. These are not necessarily unfavourable for the crops of the ensuing season.

Storms in all the islands are generally very severe, but they are not frequent. Very heavy falls of rain sometimes take place in a few hours. The bad weather which is usual at the time of the equinox is always welcomed if it come before the equinox, as it is considered a prognostic of a favourable season. On the other hand, it is the general experience of the islands that if it is delayed till April, the whole summer is irregular, and the crops do not succeed. This general experience, however, appears to have been contradicted by the present season.

In all the islands it is considered that the winds, when they once establish themselves steadily from the north or south, remain in the same quarter for many months. Thus, when during the early part of winter, in November and December, there is a gradual settlement of the wind till it blows almost always from northern quarters, the winter remains dry, clear, cold, and fine, with little rain, till the end of February. If a disturbance takes place, it rarely lasts forty-eight hours, and then the same fine weather recurs. On the other hand, if the south winds prevail, there is a warm, damp winter, with much rain. Occasional changes will bring one or two clear, cold days; but on the whole, there is more cloud and less evaporation than in the other event.

The islands differ from each other a good deal in climate, and that of Santa Maura, though so near, is not the same as that of the mainland of Greece. It is described as being always more pleasant and insular, cooler in summer and less cold in winter. The result is seen in the greater fertility of the island, and its richer and more varied crops. Corfu being more to the north, and more directly under the influence of the Albanian snow-mountains, is very different from all the others, and the air during winter is often cool, and even very sharp.

The quantity of water in the various channels and gulfs and other inlets with which the islands abound, is greatly affected by the winds. After a continuance of wind from northerly quarters, it falls so low that hundreds of acres of land are left

dry; but when a sirocco comes, it rises immediately within a few hours, even above its ordinary level.

Although the small bays and gulfs of the channel of Corfu, the Gulf of Molo in Ithaca, and the Gulf of Argostoli in Cephalonia, are all greatly and rapidly affected in this way, it is chiefly the lagoon of Santa Maura that exhibits the result of change of wind. In this great shallow expanse of water a single shower, accompanied by a south wind, will make a difference of a foot in the height of the water.

This lagoon of Santa Maura cannot but have much influence both on the climate and sanitary condition of the island; but as it is the only case within the Ionian group of a phenomenon of the kind, and is remarkably interesting in reference to another question, we shall come back to it presently. So far as climate is concerned, it is probable that there has been rather an improvement than a deterioration during British occupation; and the facts here would seem to show, that as a swamp is more dangerous than a lagoon, so a half-dried, or even dried, swamp is worse than one covered with water. That the dangerous and perpetual malaria of the eastern Mediterranean shores and islands is rather the result of ancient than existing marshes, is a conclusion forced upon us by the consideration of the facts, and is fully confirmed by everything seen in the Ionian Islands. All the islands suffer occasionally from malarious fever, and in each case the dried levels are the dangerous grounds. The kettle-shaped valleys of Corfu and Santa Maura, the head of the Gulfs of Samos and Argostoli in Cephalonia and Basilike in Santa Maura, the low lands near the Bay of Chieri in Zante, and the Salinas of Govino and Lefkimo in Corfu, are all of the same kind, and are always most mischievous after having become dry.

Cephalonia is said to have a better and more pleasant climate than Zante, and though the two islands are so near, approaching within eight miles at one point, I believe this may be the case. Owing to the prevalent winds and the position of the high mountain chain of the Black Mountains in the larger island, Zante, which lies due south of Cephalonia, receives the chill from the snow on these mountains much more frequently and thoroughly than the adjacent valleys. The winds, from whatever quarter they may originally come, are always practically north or south when they reach the islands. Thus, all the north winds bring cold to Zante, but not to Cephalonia, while the south winds are alike, or nearly so, in the two islands.

On the whole, the climates of all the islands seem pleasant, but not healthy—or at least, they require great caution at certain seasons. The rainfall is considerable, but never excessive, and though the summer heat is great, it does not seem to

be often extended so long or begin so early as to interfere with the crops of corn and grape. Ithaca is perhaps the most healthy of the islands, and it is precisely that one which has neither swamps nor kettle-shaped valleys.

Santa Maura—in ancient times Leucadia—is remarkable for its very close proximity to the mainland of Greece, from which it is only separated by a water channel so shallow that the distance can easily be crossed on foot, even by women and children. The island is thus a peninsula connected by an isthmus just covered with water. In this respect, and also in the nature of the isthmus, it offers some interesting peculiarities of physical geography.

The whole island is mountainous. The principal range traverses the middle, from north to south, culminating in two lofty peaks near the southern end. On either side, to the east and west, there is a coast range, less lofty. The eastern and central ranges terminate abruptly towards the north; the western range is continued a little further with steep cliffs towards the sea. At the foot of the furthest extremity of this cliff a low spit of gravel, just above the sea-level, runs off towards the east and continues between two and three miles, terminating in a reef. Beyond this, to the north, is deep water, but towards the island a very shallow lagoon. The narrowest and shallowest part of the channel is between the extremity of this reef and the Greek shore, not far from the foot of a tolerably high hill. It is only about 200 yards across, and in some parts only a few inches deep. This is the northern boundary of the isthmus. It has been cut asunder artificially about mid-way by an artificial channel, part of which is a harbour, and this has been continued for some distance as a ship canal. If completed, it would greatly facilitate the navigation of the Greek coast, and it is believed that there is no tendency to choke a channel once formed.

The southern boundary of the isthmus is between two and three miles to the south. The eastern coast range is here distant from a hill on the mainland something less than a mile, but the interval covered by water is only about 350 yards. This channel is, however, much deeper than the northern, and ships of considerable size can safely enter. Between the northern and southern boundary is an extensive tract of very shallow water, gradually filling up by the detritus which comes in by many small streams after rain, and certainly very much reduced in area within the last score of centuries. No ordinary boat can be paddled across it.

What is called the lagoon of Santa Maura is, then, really a low flat beyond the extremity of a bay, or gulf, running up between the peninsula

of Leucadia and the mainland of Greece. Receiving the drainage of a considerable tract of land, much of it hilly, the heavy rains that occasionally fall carry into it a good deal of silt; and marine currents coming in, either from north or south, help to increase the deposit which is rapidly forming and hardening at the head of this gulf. Unless interfered with from without, the whole tends, ultimately, to form a wide tract of dry land. The narrow passage near Teki Castle does not tend to become deeper; and, indeed, the water is already so shallow there that it can easily be waded across. The passage at Fort Alexander is both wider and deeper, but still has no tendency to check but rather increases the deposits within the present area of shallow water. The completion of the ship canal, if successful, might slightly check the filling up of the lagoon.*

The existence at present of this curious condition of a large island so very nearly connected with the mainland by a channel apparently tending to choke up rather than to widen, is the more interesting because in two cases in which it is alluded to by writers of antiquity, it is described as then actually a peninsula. Thus, Homer describes it as "the peninsula of Epirus," while Livy, describing the seige of Leucas by the Romans about two hundred years before the birth of Christ, speaks of it as in his time an island, but at the time of the siege a peninsula.

Notwithstanding this, there is the best reason for supposing that the water way, such as it is, has always existed. Homer might well call it a peninsula, if the intervening water could be waded across on foot, and Livy may have misunderstood his informants for a similar reason. Certainly, there is no present appearance of there having been a separation, either natural or artificial, within the historic period. That the whole district is subject to occasional earthquake action is undoubted, and it might be supposed that on one of these occasions some small depression has occurred, lowering, by a few feet, a tongue of land like that which still forms the margin of the lagoon to the north. Such an event as a small depression might detach Gibraltar from Spain in a similar way. But a sinking of this kind cannot have affected only a part of the long narrow strip, all of which is in the same state. A depression now of a few feet would not only lay open the whole lagoon to the sea, but cover most of the plain on which are the town of Santa Maura and all the rich olive-groves adjacent, nearly to the foot of the hills. A depression of five feet would leave hardly anything. On the other hand, all these plains and the margin of the lagoon are strictly alluvial, the plains being chiefly river alluvium, and the margin entirely marine alluvium. Had the whole been originally and during the historic period five feet higher, there

* Austed's "Ionian Islands," p. 133.

would certainly have been no lagoon at all, but a plain gently sloping to the water's edge, and the margin need not, and could not, have been composed of a marine alluvium cemented together. It would, on the contrary, have presented a low cliff to the sea, and the remains of this cliff must have existed somewhere. There are no marks of it; while, on the contrary, all, without exception of the margin, is an evident drift of pebbles, the result of occasional high winds from the north bringing up the water and moving the shingle with it. This margin, also, is not always narrow. In one part it bulges inland and forms a kind of island, on which is a farm and chapel. Another similar land-tract is occupied by the fort of Santa Maura, built many centuries ago, and still occupied.

If, indeed, there has been any change in the level of this part of the Mediterranean, it has more probably been that of elevation than depression. A very slow elevation, accompanied by atmospheric action, would better account for the phenomena presented by the margin and the gradual filling up of the lagoon.

Marks of elevation on a much larger scale are sufficiently common along the whole eastern coast of Santa Maura, but they belong to a pre-historic period. Marine alluvia, of comparatively modern date, have there been formed, of great thickness, and have been brought up to the height of many hundred feet, at an angle of 60°, the beds dipping towards the sea. The thickness of these beds is very great, and they are repeated in various forms in some of the other islands.

One of the peculiarities of most of the Ionian Islands is the existence of a surface deposit of pebbles or angular stones, in some places small and in others large, and of various thicknesses, cemented into a pudding-stone, and covering the surface. These might sometimes be thought a marine formation; but they consist only of the stones at the surface weathered and broken by exposure, and worked into a solid mass by the infiltration of rain-water. It is a condition only possible to such an extent in a limestone district where weathering goes on rapidly. It is necessary to remind the reader of this, as he might easily fall into the error of supposing that these breccias were also proofs of elevation.

Although there is no probability that the separation of Santa Maura from the mainland of Greece is a modern event, there are not wanting in all the islands abundant proofs of recent volcanic disturbance. Earthquakes are exceedingly common, and in Santa Maura, Cephalonia, and Zante, they have been extremely injurious within the last few centuries. There are however, some interesting peculiarities connected with them, amongst which may be mentioned that, although all the islands

are subject to shocks, occurring *about* the same time, the same shocks do not extend from one island to another. As an instance, I may mention a case that came under my own observation:—In the early morning of Saturday, the 21st March, while sleeping at Attane on the west side of Santa Maura, I was disturbed by a distinct shock of an earthquake, which also woke everyone in the house. I felt my bed rock under me; but although attention was naturally directed to the subject, no other shock was felt. At the same time as at Attane, or within a few minutes, a shock threw down some buildings in the town of Santa Maura, at a distance of more than twelve miles to the north-east. On the same day also, but towards noon (many hours later in the day), there were several shocks felt at Argostoli, in Cephalonia, less than forty miles in a direction a little to the west of south, accompanying a frightful electric storm and a cyclone which tore up a large number of old olive-trees by the roots, and so severely shook the walls of some barracks that they had to be taken down immediately. I heard of many other similar cases, in which the interval was longer, amounting to one, two, or three days. It is also on record, that many of the earthquakes that have desolated the islands have been preceded by great atmospheric disturbance.

Earthquakes of moderate intensity are very frequent in the islands of Santa Maura, Cephalonia, and Zante, but have proved most mischievous in the towns of the first and last named. Santa Maura was greatly injured and almost destroyed in the early part of this century, and the houses and other buildings since erected are provided, accordingly, with very large stone posts buried six feet in the rock, and rising about as much above ground. On the framework thus prepared a construction is placed, chiefly of wood, which is kept low, and supports a light roof, so that, in case of a shake, as little damage shall be done as possible. With the same view, the bell-towers of the churches are placed away from the building, and scarcely any of the buildings are more than one story above the ground.

Zante has, perhaps, suffered more than any of the islands from severe earthquake shocks. In the year 1514 there was a great shock that is said to have split asunder the castle hill behind the town from top to bottom. The old town of that date was then, no doubt, destroyed. A succession of disturbances of a smaller kind took place at intervals till 1840, when, once more, the whole island was affected. During the latter part of this year (1840) the great volcanic district of the Eastern Mediterranean and Asia Minor was greatly shaken, and the disturbances extended far into Persia and the East.

In the middle and end of June the district of Mount Ararat, in Armenia, was the scene of very numerous violent eruptions. These were continued at intervals throughout July, accompanied by occasional shocks, at Naples, and in Styria, Illyria, and Lombardy, where much damage was done. In the middle of August there were other disturbances in Naples and its neighbourhood, and from the 28th to 30th October, Zante was shaken by nearly a hundred violent shocks within a week. The first shock was felt at sea, in a steamboat, six miles from the land. Still later in the year—in November and December —disturbances were felt both in Calabria and Armenia, and in the following January in Algiers. Lastly, on the 18th of February, 1841, very severe shocks were felt in parts of Italy, and on the 26th of the same month a most alarming shock again affected the town of Zante, the vibration lasting more than half a minute. This last disturbance was preceded by three days and nights of incessant rain, with violent gales of wind.

These earthquakes are the more interesting, as no record is given of any shock in the other Ionian Islands within this period, and the shocks, if there were any, must have been very slight. It is not recorded that any damage was done in the Morea by either of these great Zante earthquakes.

Probably connected with the origin of these local, though sometimes severe, earthquake shocks, are the deposits of sulphur and pitch, and the conversion of large quantities of carbonate into sulphate of lime, besides the occasional outburst of springs of water loaded with sulphuretted hydrogen. I have already suggested that below the limestones which were deposited as a floor over the Mediterranean before the upheaval of these islands, there is probably a sheet of lava, the result of volcanic eruptions in this district, which we know to have been, during the late tertiary period, the seat of extreme and very widely-spread volcanic action. Through cracks in this lava proceed, or have proceeded, sulphurous vapours, and these have ultimately made the changes.

I have alluded to the mountains of Corfu, which, to a certain extent, is an outlying island; but it still remains to describe the mountain system of the other islands. Of these, the Black Mountain of Cephalonia forms the key and the most strongly-marked example. It consists of a single narrow north-north-west and south-south-east ridge, attaining the considerable elevation of 5,300 feet. It is very nearly parallel to the chain forming the western side of Zante (rising to about 2,300 feet), and also to the whole range of Ithaca. There is an intermediate and much lower range between the Black Mountain and Ithaca, forming the coast range on the east side of

Cephalonia, and this is continued to the northern extremity of the island, though broken asunder by the Gulf of Samos. The ridge of Ithaca extends northward into Santa Maura, broken by the channel between the two islands, but indicated by the smaller island of Arkudi between them. It culminates in Stavrota and St. Elia, the two highest points in Santa Maura. From this the axis continues, and though again broken by a narrow interval, is traceable into the mainland of Acaruania. The whole of this line of mountain country may be regarded as in a general sense parallel to the direction of high ground in southern Greece; but the elevations generally are much less considerable.

The character of the mountain ranges is not precisely the same in the different islands. Thus, the Black Mountain presents a very well-marked series of ridges all nearly of the same height, while Stavrota and St. Elia, in Santa Maura, Santi Deca, and St. Elia, in Corfu, and Vrachiona, in Zante, are separate pyramidal peaks, and San Salvador with Maviona, in Corfu, are two culminating pyramids at the extremities of a high east and west ridge. On the whole, it will best explain the physical conditions to describe each island as either consisting of or including a high plateau, with occasional higher ridges, while Cephalonia, in addition, presents a sharp, central ridge.

Of valleys, the most remarkable and exceptional forms have been already described in the first part of this article. They are repeated, with some variation, in all the islands. Valleys of the ordinary kind are hardly to be seen, except in Santa Maura and Cephalonia, though small instances also exist in Zante. Corfu is singularly without anything of the kind, except in the northern district, where they are very small.

On the whole, then, it will be evident that the physical geography of the Ionian Islands, considered as a group, is well worthy of notice. These islands are especially remarkable as illustrating all the characteristic peculiarities of limestone rock, referring to the forms of the land, the natural drainage, the climate, the weathering by atmospheric exposure, and some very singular local phenomena. There are probably very few accessible districts in which so great and instructive a variety of such scenery is to be met with, and nowhere in Europe is there better opportunity for the geologist to observe the effect of natural causes of change on calcareous rock. With the exception of soft, friable chalk, almost all the varieties of the mineral are met with, from hardened chalk through limestone to marble on the one side, and through the varieties of marl to gypsum and alabaster on the other. Limestone masses, limestone beds, limestone conglomerates, limestone and marble veins, and

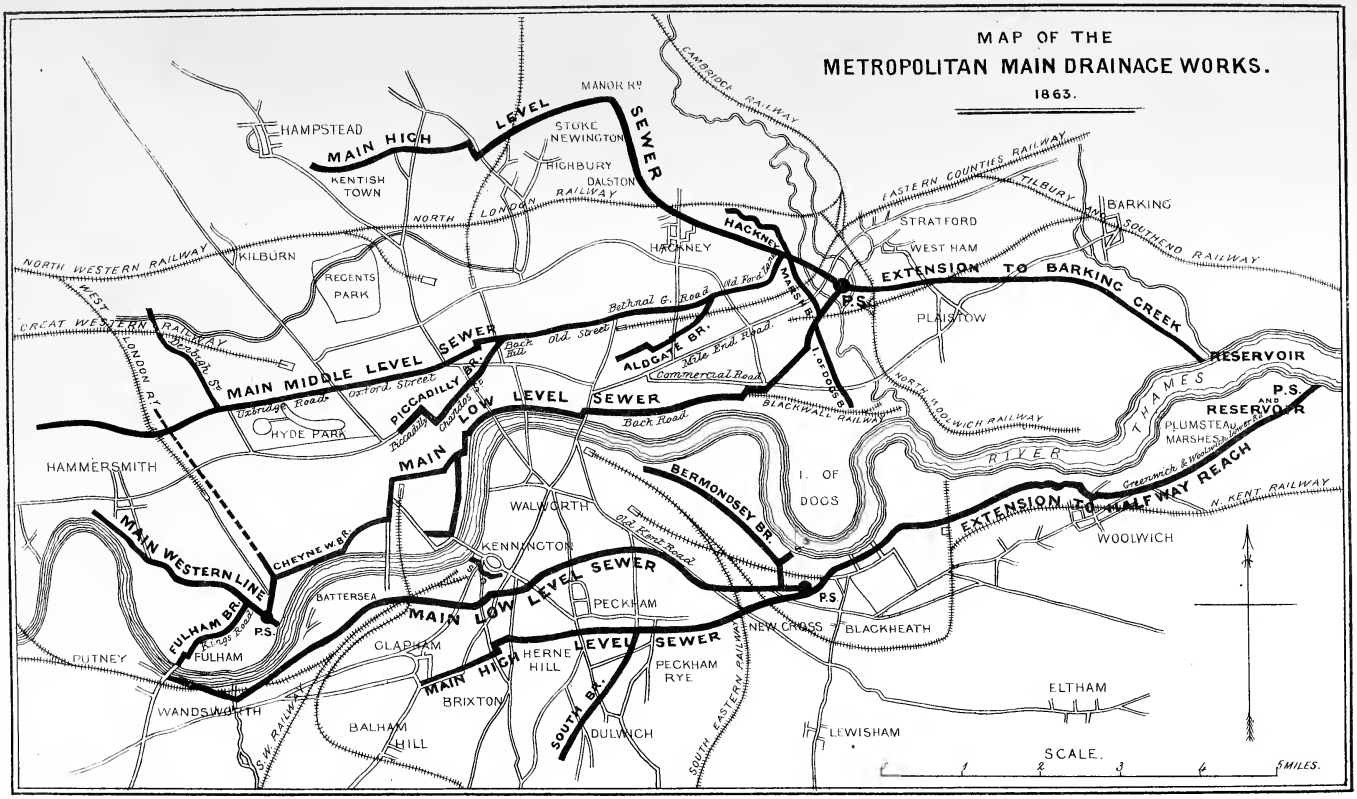
metamorphic limestones may all be found. Mineral veins, however, in the limestone are not common, and lead and zinc ores, common in cases where the limestone is less pure, are not known in the district. Sulphur is the only important mineral hitherto discovered, and this is not in veins, but either bedded or nodular. Caverns are common; but no very large ones have been described, except in Cerigo. In the other islands they are small, and have been traced only to a short distance, owing probably to the tenderness of the limestone, which falls in before very large open spaces have had time to form. What is wanted in extent is doubtless made up in number, and it is certain that the rock is everywhere much fissured, and freely open to the passage of water.

The islands are unquestionably more interesting in their physical geography than in their geology, and most of the points of geology have already been alluded to as related to existing operations of nature. Of fossils, few have been found, and these possess no great interest. Perhaps some day a careful examination of the contents of the Cerigo caverns may throw light on the great question of the existence of human beings in Europe together with the large extinct quadrupeds; but there is no evidence yet. The hipperite limestone of Cephalonia is fossiliferous, but has not produced anything new. The tertiary limestones and marls near Argostoli, also in Cephalonia, have been found rich in specimens, and are worth more careful working than they have yet received.

THE METROPOLITAN MAIN DRAINAGE WORKS.

BY S. J. MACKIE, F.G.S.

WHEN people see the roadways torn up, and the traffic blocked by fencings of planks round deep well-holes in our busy streets, they are puzzled often to conceive what connection these isolated diggings and workings can have with each other. Beyond the general idea that the new drainage works are to take the sewage away from our houses and deposit it in the river at Barking Reach, they have little notion of what the metropolitan drainage operations are; and yet, in these gigantic undertakings, there is little in the general plan that is not readily intelligible and simple. To get rid of anything we must make use of natural or artificial force. The refuse from our houses could be carted away, or it might be allowed to run off. In the first case, labour and artificial locomotion would be required; in the latter, the natural force of the earth's gravitation would do the work for us. The former would be costly and troublesome; the latter is inexpensive and gratuitous. For liquids to run naturally away, we require an inclination of the surface, so that the constituent atoms may come under the influence of gravitation, in the same way as a handful of marbles will roll down a sloping board. But if the fluid be required to move a solid, the rate at which it flows must be increased, or, in other words, the inclined plane must be made the steeper, that the motion of the fluid may approach more nearly to that of a directly falling body. The steeper the incline, the greater the power of a liquid to move and carry along extraneous solid bodies. In drainage works, then, the primary object is to use gravitation as the removing power, because it is enduring and ever continuous, costs nothing, and wants no looking after; while the secondary object incident on the application of this principle is to get as "good a fall"—that is, as steep an inclination—as possible. In a small town merely crowning the crest of a solitary hill this matter would be simple enough; but where a large city like London spreads over many square miles, and includes in its area undulating and irregular land of every degree of elevation and depression, from 400 feet above Trinity


MAP OF THE
METROPOLITAN MAIN DRAINAGE WORKS.
1863.
MAIN HIGH LEVEL SEWER
MAIN MIDDLE LEVEL SEWER
MAIN LOW LEVEL SEWER
MAIN WESTERN LINE
MAIN HIGH LEVEL SEWER
EXTENSION TO BARKING CREEK
EXTENSION TO HALFWAY REACH
HAMPSTEAD
KENTISH TOWN
MANOR Rd
STOKE NEWINGTON
HIGHBURY
DALSTON
HACKNEY
HACKNEY MARSH
STRATFORD
WEST HAM
BARKING
PLAISTOW
KILBURN
REGENTS PARK
HYDE PARK
HAMMERSMITH
WALWORTH
KENNINGTON
BATTERSEA
PECKHAM
CLAPHAM
HERNE HILL
PECKHAM RYE
BRIXTON
BALHAM HILL
DULWICH
NEW CROSS
BLACKHEATH
LEWISHAM
ELTHAM
WOOLWICH
PLUMSTEAD MARSHES
RESERVOIR
P.S. AND RESERVOIR
I. OF DOGS
BERMONDSEY BR.
ALDGATE BR.
PICCADILLY BR.
FULHAM BR.
SOUTH BR.
CHEYNE W. BR.
P.S.
NORTH WESTERN RAILWAY
WEST LONDON RY.
GREAT WESTERN RAILWAY
NORTH LONDON RAILWAY
CAMBRIDGE RAILWAY
EASTERN COUNTIES RAILWAY
TILBURY AND SOUTHEND RAILWAY
NORTH WOOLWICH RAILWAY
BLACKWALL RAILWAY
SOUTH EASTERN RAILWAY
S.W. RAILWAY
N. KENT RAILWAY
THAMES RIVER
Bethnal G. Road
Old Ford Lane
Old Street
Back Hill
Mile End Road
Commercial Road
Back Road
Old Kent Road
Uxbridge Road
Oxford Street
Piccadilly
Chandos St.
Denbigh St.
Kings Road
Greenwich & Woolwich Lower Rd.
SCALE.
1 2 3 4 5 MILES.

BRITISH MUSEUM
NATURAL HISTORY

high-water mark to several feet below it, the task is one requiring the greatest skill and care; and this difficulty is still further increased by the existence of previous systems and networks of drains, by subterranean lines of water-pipes and gas-pipes, lines of houses, the excavation of cellars, roads, streets, railways, bridges, and intersecting rivers; to each of which belong rights of property, which must be respected. If we could cut an open trench at a given incline, the liquid sewage would flow along it just as a river in its channel, moving along by its momentum the solid objects in its course; but the offensive nature of town-refuse requires that its course should be covered over, to prevent injury to the health of the inhabitants from its noxious emanations. Once inclosed, the sewer assumes the nature of a pipe, and becomes immediately subject to the laws of hydraulic pressure. Filled with the sudden influx of waters from storms, it would burst; stopped with solid accumulations, it would require cleansing. It must be made steep enough to induce motion in its contents, large enough to carry off storm-waters, and sufficiently ventilated for workmen to enter to clear out stoppages and obstructions. Other subsidiary points, it will be seen, come in. For example, if we observe a contour map of London, we shall see the irregularities and undulations of its surface are not altogether devoid of a certain method and order, and in the main resolve themselves into the general valley of the Thames, like the sloping sides of a double roof towards a central gutter. It is evident that, if we allowed the sewage to flow laterally down from the highest slopes into a central main drain, running through the entire length and median line of the metropolis like an under-ground river parallel with the Thames, we should require a culvert of enormous size, to provide not only for the sewage, but the rain-fall of the whole district, and that the hydraulic pressure upon the masonry of the culverts would be of the highest tension, while the liability to accident would be of the most risky character. The more, then, we can divide a district, the smaller the streams of sewage the drains will have to carry, and the less the danger from sudden floods when there are several channels for the waters to run off by. Hence the principle of intercepting drainage. If we wished to stop the run of water from our roofs into the central gully, two or three smaller gutters placed more or less diagonally along their sides would arrest at intervals the water flowing down their slopes, and convey that which fell on the different areas, thus isolated from each other, in separate streams to the head of the "down-pipe" into the streets. On the like principle the main drainage of the metropolis consists of intercepting sewers at various levels, so that instead of one great drain for

the whole region, there are no less than six chief lines of sewers; or, rather, there are two distinct drainage works, of three main lines each; one system draining all the districts on the north side of the Thames, the other all those on the south side of the river.

The northern system consists of a high level, a middle level, and a low level main drain; the southern system of a high level, a low level, and the Effra main drain.

The Northern High Level main, consisting of a brick culvert, varying from 4 feet in diameter to 9½ feet, starts from Hampstead at an elevation of 154 feet, and passes through Kentish Town, Holloway, Stoke Newington, Clapton, Hackney, and Homerton, with an incline of 132 feet in a length of nine miles, to the Old Ford over the Lea at Bow, where the Northern Outfall sewers commence that carry on the sewage of the main drains to the exit into the Thames at Barking Creek. The Northern Middle Level sewer, which is of brick, and of like dimensions, starts from the cemetery at Kensal Green, passing through Notting Hill along the Uxbridge Road, intercepting the Ranelagh sewer which brings the drainage from Hampstead and Kilburn at the Gloucester Road, continues along the Uxbridge Road to Oxford Street, where it intercepts the King's Scholars' Pond sewer at Duke Street, and thence along Oxford Street, intercepting the Regent's Park Tunnel sewer at Regent's Circus. At this point there is a weir and overflow chamber, to allow the storm-water to pass over and flow down the old sewer-course. The Middle Level sewer then passes along New Oxford Street, Hart Street, Theobald's Road, Liquorpond Street, Bedford Row, to Victoria Street, Clerkenwell, where it crosses, by means of an iron culvert, over the underground railway near the Farringdon Street terminus. Here also it intercepts the Fleet sewer, and then goes on through Old Street, across Shoreditch, along Bethnal Green Road, to the junction of the High Level and Outfall sewers at Old Ford. This sewer with its branches runs over twelve miles and a half in length, the head from which it starts being 64 feet above the Trinity datum line. Both these sewers flow the whole distance, from their origins to their terminations, by gravitation.

The Northern Low Level sewer commences at 6 inches above Trinity datum at Hammersmith, about a mile west of the bridge; another branch coming from Acton, and a short branch through Fulham from Putney Bridge. The sewage thence will flow to a pumping-station at Pimlico, where it will be lifted from 17 feet below the datum. After the junction its course will lie—for this portion is not yet constructed—through Chelsea, close to the river, past the Hospital,

through Belgravia, joining the Victoria sewer at Pimlico; its course will be then along Victoria Street, through Scotland Yard, to Hungerford; then along the line of the Thames embankment and the new street by the river bank (the powers for making which were obtained from Parliament last session) to Cannon Street, whence it proceeds by Tower Hill, Back Road, Commercial Road, Limehouse, Bow Common, to a second pumping station at Abbey Mills, where its whole contents will have to be lifted 15½ feet, by an engine of 600-horse power, into an outfall sewer, through which the sewage will then run by gravitation parallel with the High and Middle Level Outfall sewers to Barking Creek. It will be seen that thus the High and Middle Level sewers flow side by side from Old Ford, 22 feet above datum, passing across the River Lea and under the Great Eastern Railway and the Stratford Road, to the Abbey Mills, and that thence there are three outfall sewers for the High, Middle, and Low Level sewages respectively, running together eastward, and carried, partly on embankments of concrete and partly on a viaduct of brick arches, over the low-lying marshy land of the districts of Plaistow and Eastham, for a distance of nine miles and a half to the Thames at Barking Creek, where there is a reservoir of ten acres in extent, divided into four compartments as a provision for repairs, cleansing, or accident. The sewage collected in this reservoir will be only allowed to escape after the turn of high water, the outward current of the river then carrying it for twelve miles further down, and being, in fact, equivalent, as far as the metropolis is concerned, to that additional length of drain.

The drainage works on the south side of London are entirely distinct from those of the north side. The Effra Main Drain commences at an elevation of 90 feet at the Crystal Palace, and passes through Dulwich, East Dulwich, Peckham Rye, and New Cross to Deptford, a distance of four miles and a half, where it is pumped into the Southern Outfall sewer. The Southern High Level Main Drain commences at Clapham, at 51 feet above Trinity datum, running through Stockwell, Brixton, Camberwell, Peckham, and parallel with the Effra from Hatcham, through New Cross to Deptford; its length being five miles and a quarter. The Southern Low Level Main Drain commences at Putney, with a head of only 9 feet. Thence it passes through Wandsworth, Battersea, by Nine Elms to Kennington Oval, continuing along the Camberwell New Road by the side of the Surrey Canal, across the Old Kent Road by Peckham New Town, to the Pumping Station at Deptford Creek; being joined near the Deptford Railway Station by the Bermondsey branch, running through Rother-

hithe and Deptford, a length of ten miles to 18 feet below datum. From Deptford one general outfall sewer, 11 feet 6 inches in diameter, conveys the drainage matter through Greenwich, by the Woolwich Lower Road, by a deep tunnel under the town of Woolwich, then along the Plumstead Road, and afterwards north-easterly across the marshes to a point called Cross Ness at Half-way Reach on the Thames —a distance of seven miles and a half—where the whole sewage will again be lifted into a vast covered reservoir, six acres and a half in extent, and discharged after the turn of high water into the river.

The objects sought to be obtained by these works are primarily to remove from the river Thames, in its course through London, the noxious contamination of the nearly sixty millions of gallons of sewage now daily poured into it, by intercepting that sewage in its progress towards the river, and diverting it in covered channels as far as possible, by gravitation, to points some fourteen miles below London Bridge, where it will be discharged into the bottom of the river during the first two hours of ebb-tide only, when the sewage, deodorized, will be further diluted by twenty times the volume of water which now dilutes it in the London area. In this way it is considered the ebb-tide will practically convey the sewage to an ultimate distance of twenty-six miles from London Bridge, and surrender it there to the sea.

When a plan is formed, it requires to be put in execution: having determined the lines of drainage, we have to construct the drains. It is evident, from the undulating nature of the surface, that there must be differences of inclination in various portions, and that at places the ground will sink beneath the plane of the sewer, unless it be excavated very deep indeed, to do which would be to diminish the power of gravitation, or to necessitate uplifting by engine-power—a perpetual cost it would, of course, whenever possible, be most desirable to avoid.

The ground, therefore, is accurately surveyed, and all the irregularities of elevation referred to a given base-line—the ordnance datum, 12ft. 6in. below Trinity high-water mark.

In London this operation is greatly facilitated by the registered marks of the Ordnance Survey, who have accurately levelled through the metropolis, and affixed inscribed marks upon the houses and public buildings in every street and highway, so that the height of these marks being exactly known, they can be at once adopted, without recourse to a tedious process of levelling from the datum-line itself.

Upon such a section, thus obtained and plotted down on

paper to scale, the future works are designed and estimated exactly in every possible particular, so that the builders' contracts are taken upon these designs. Everything is preconceived and studied—the amount of rainfall upon each area; the quantities of sewage now flowing, or to be provided for; the incomings along the course of the sewer, so that its size may be determined; and by starting with the smallest requisite size, and increasing its dimensions as it proceeds, economy of labour and material is acquired without, in the

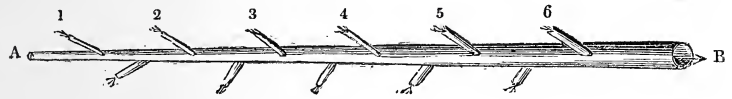


Fig. 1. A, Commencement of sewer, say 4 feet, such dimensions gradually increase to 10 feet 6 inches at the termination B. 1 to 6 lateral incoming sewers along its course.

smallest degree, impairing its efficiency. The thickness of brickwork, where iron culverts are required, their size, form, and length; how they are to be supported, how joined to the masonry of the sewer; how the drains shall be carried over valleys, rivers, or low-lying marshes, whether by pipes, embankments, or viaducts of arches; where there shall be pen-stocks, and flushing, and pumping-stations; the extent and height of reservoirs, the power and dimensions of the pumping-engines; what kind of brick, or stone, or iron shall be used for each special purpose;—in short, everything, down to the very mouldings and ornamentation of any sightly portions, is all contemplated, drawn on the plans, and entered in the specifications. Modifications, from unforeseen circumstances, or for various reasons, often take place during the practical performance of such undertakings; but in the present case it is but justice to notice the extreme care and accuracy with which all the details, even to the minutest, have been got out and strictly adhered to. When, then, the contractor goes to work, he has before him the exact measurements, elevations, and descriptions of everything he has to do. Suppose, for example, he has a thousand yards of sewer to construct, starting with an elevation of 90 feet and falling one foot in a hundred yards, or to 80 feet elevation at its termination. If the surface were a true level, the operation of laying the drain would be very simple: he would merely have, at every hundred yards apart, to sink down a foot lower in each case, and give a general incline in laying the floor of the drain from one spot to another. But no surface exists so level and true that this can be done; the exact height, therefore, of the exact spot where the sinking is to be made to "drive the headings," or the excavations of the earth-tunnel in which

the sewer is to be built, must be ascertained. If there be an Ordnance-mark near at hand, say indicating 102 feet, the surveyors level from this by the spirit-level to the spot for the sinking; they rule lines, as it were, with the telescope of their instrument parallel with the datum-line.

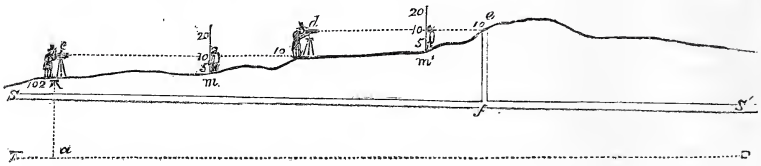


Fig. 2. Method of levelling for determining the depth of the work.

Suppose two levellings are taken, the fine horizontal wire across the lens of the telescope accurately adjusted to a perfect level cutting the mark of ten feet on the staff the assistant holds a convenient distance away on each occasion, it is evident we have added 20 feet in elevation to the original height at the spot *c*. One hundred and two feet plus twenty are 122 feet—the elevation, then, of that spot; and one hundred yards being the distance between *a* and *c*—the fall of the sewer adds one foot additional for the depth to be sunk at *c*, making a total depth of 21 feet from the surface to the floor or invert of the drain. When, therefore, this depth is roughly attained by the well-sinker, the surveyor makes an accurate measurement with the tape, and drives pegs at the exact spots, the excavators make their tunnel, and the bricklayers work to these pegs just as they would work to given lines in their ordinary operation upon the surface. The form of the sewers often varies. Sometimes it is round, sometimes oval, rarely square; sometimes compounded of various segments of arches struck from different centres. These modifications depend on the quantity of sewage, the nature of the ground, and the character of particular obstructions; the flat or square portions being, for example, adopted where the quantity of sewage is great, but the drain lying near the surface, or too close beneath some obstructive object to permit of its being built of its full height. Where open gaps occur, as at the underground railway-cutting in Victoria Street (Farringdon Street), iron culverts are used to bridge over the void beneath. But iron expands and contracts with variations of temperature, and such expansion or contraction is almost, one may say, irresistible in its force. In expanding, the iron must either contort itself, or push down or out the brickwork on which it presses; in contracting, it would leave an open space between, and the sewage would leak out. Provision,

therefore, must be made for these well-known alterations in iron materials.

For the illustration of engineering operations, no better portion of the metropolitan drainage works can possibly be taken than that between Old Ford and the Stratford Road, at Bow. At Old Ford the High Level and Middle Level Sewers make a junction or rather meet at a pen-stock, by which, for repairs, or during storms, communication can be made between them, or with a storm overflow into the River Lea; for the sewers themselves run on side by side, touching, but not actually joining.

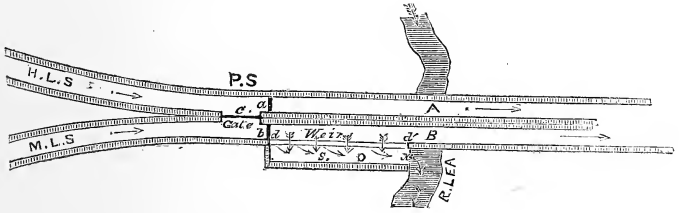


Fig. 3. Plan of Old Ford Pen-stock. H. L. S. (High Level Sewer). *a* gate. M. L. S. (Middle Level Sewer). *b* Gate. *f* Connecting gate. *c c'* Storm weir. *c* Storm outlet running into the river Lea at *x*.

The accompanying diagram, representing in a general way the arrangement at Old Ford, will convey an idea of the nature and use of a "pen-stock." The two main lines of sewers are seen approaching each other, the arrows indicating the direction in which the sewage is flowing. At *f* is a gate usually *closed*, each current of sewage then passing along its own special sewer. If an impediment take place in the High Level Sewer in the portion at *c*, or further on its course towards the outfall, the gate *a* being closed stops the sewage from passing along it, and the intermediate gate *f* being opened allows it to flow into the Middle Level main. *Vice versâ*, the gate *b* bars the passage of the Middle Level sewage when the opening of the communicating gate *f* gives vent from it into the High Level main. The same in the case of storm-waters when the flow is excessive, for it is necessary to bear in mind that ordinarily the drains are not even half full or anything like it. But during storms the volume of fluid passing is enormously augmented, and unless provisions were made for such storm-waters, their hydraulic pressure in extreme cases would burst the barrels of the drains. In order, therefore, to provide against such emergencies, additional communications are also made for the surplus storm-waters to run off by "storm-outlets" into the rivers or old drains. A provision of this sort is made at Old Ford.

The wall *e e'* at the side of the Middle Level main is built, say three-fifths of the way up, but is left open above that height, so as to form a weir. When the storm-waters rise above its brim, they fall over into the storm-outlet *c* and run off at *x* into the River Lea.

The accompanying diagram of the overflow at Regent Circus gives a cross section of one of these weirs.

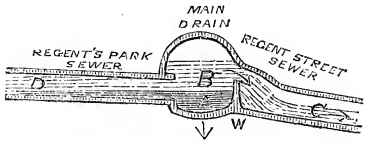


Fig. 4.

From Old Ford the brick mains proceed *under* the North London Railway until they arrive at the Lea, where two wrought-iron culverts bridge over that river. They are 84 feet in length and 9 feet in diameter; and repose upon two solid stone piers—one on each bank. In the two tubes there are upwards of 70,000 rivets. We have spoken before of the expansion and contraction of ironwork by the natural variations of temperature. This is thus in this case provided for:—We will, for simplicity's sake, take one culvert as an illustration for both. The culvert rides quite free at both ends on iron cradles supported on rollers, running on slabs of planed iron fixed to the floors of the stone piers. The free ends of the culvert project for some distance into the brick sewer, and the junction of the expansible culvert with the immovable brickwork is made by means of a fold of the best milled sheet-lead. In the figure $c^1, c^2, c^3\ c^4$ represent the iron culvert, the free end of which $c^2\ c^4$ (having a tendency to expand towards *e*) projects into the open end of the brick main x^1 *x*. One edge of the folded sheet-lead is fastened by an iron plate to the end of the brick main all round its mouth. The opposite edge of the lead is attached to a flat iron ring passing round the culvert. If the culvert expand, the fold is pressed up more acutely, or rather out, for the lead-joint constitutes a bulging cylinder all round the junction. If the culvert contract, the lead-fold at *c* is drawn out and depressed. The action of this lead-joint, during the expansion or contraction of the iron culvert, may be readily understood by folding a strip of paper and holding it at each end. If we bring our hands together the fold is pushed up; if we draw them apart the fold is lowered and flattened. The cradles the culverts rest on are equally carefully considered and made. The iron culvert first rests on a broad oval

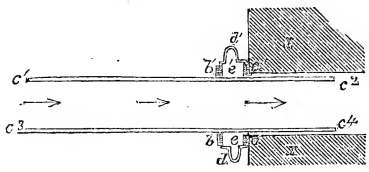


Fig. 5. Junction of iron culvert across the Lea, with the brick sewer.

plate, *a a'*, with a deep square gash in the lower part, *c*, its roof resting free upon the rounded end of the vertical bearer, *d d'*, of the cradle, *e e'*, which again is supported on two evenly turned rollers, *f f'*, which have free motion to and fro on the flat iron plane, *p p'*, affixed firmly and truly level on the masonry of the pier, *m m'*. These rollers do not rest on their axles, but have arches, *i i'*, accurately turned for the whole length of their peripheries, so that the axles, *g g'*, turn quite free in their sockets, *w w'*. Any danger of locking is thus removed, for of course if any jambing did take place, it would be equivalent to making the culvert a fixture, and damage to the works must equally arise when the drain-tube expanded or contracted as if the works had been constructed without any provision at all. This consideration at once explains the need for such exceedingly great care, in what to the uninitiated in engineering mysteries might seem an unnecessary fuss about a trifling matter. As barges and vessels pass under this culvert-bridge, its lower portion is completely ceiled over with plate-iron to prevent damage from the striking of masts or spars. The main brick sewers are throughout this district carried on a concrete bedding along an embankment; and are also covered over with concrete. At every 220 yards are man-holes for access to the interior, and at every intermediate 110 yards are air-gratings for ventilation. The form of the sewers here is like that of the Thames Tunnel, but smaller in dimensions; the arch being struck from a 4-feet 6-inch centre; the sides and floor being portions of circles struck from a 9-feet centre.

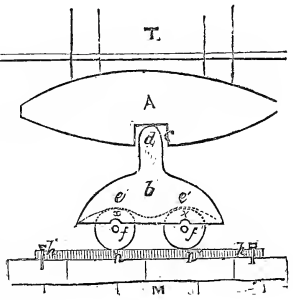


Fig. 6.

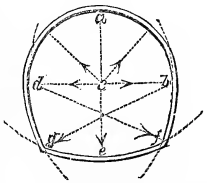


Fig. 7. Section of sewer between Old Ford and Stratford.

Three other gaps and watercourses are bridged over between the Lea River and the Stratford Road, the principal one being that across the Pudding Mill Stream, the iron culverts over which are 252 feet long, and supported on five sets of piers. The junctions of the tubes with the brick drains in these cases are made with compressed india-rubber inserted as a padding at the end of the culvert.

As the sewage flows from the Stratford Road for the rest of the distance to Barking Creek by simple gravitation into a large reservoir or receptacle there, and is thence by gates or

sluices emitted into the Thames, and as the Abbey Mills Pumping Station is but an ordinary lifting-station, such as in the Low-Level lines, of both systems, will be built at the requisite intervals when the fall of the sewers becomes too low for further continuance, and is moreover not yet in existence, we may now, having so far explained the principal engineering features of the Northern system, select the Southern Outfall works for our concluding observations; for, although the Northern Outfall reservoir and works extend over the largest area—upwards of twelve acres and a half, whilst the Southern occupy about eight acres and a half,—the latter are by far the most important and complicated. In the Northern system, all that has required lifting has been previously raised, and the sewage simply flows like a dirty river into a great pool, the larger dimensions of which are determined solely by the larger amount of area drained; and for the reservoir itself there is no other necessity than the edict of the Board of Works, that the sewage shall be let into the river only for the first two hours of ebb. The drains could not be permitted to hold it stagnant for the intervening ten hours between the tides, and therefore a basin must be made to hold it. When the appointed time arrives, the numerous sluice-holes will be opened, and the pent-up sewage will rush away. This penning-up of the sewage is also the reason for the Southern reservoir; and both reservoirs can of course be artificially emptied of their contents whenever arrangements are made for the application of the sewage to the land as manure, or for its sale for commercial purposes. While, however, on the north nature's power—gravitation—does the required work, at the Southern Outfall steam comes on duty. The differences of levels in this system cause *all* the sewage of the Southern system to arrive at the outfall at some feet in depth below low water. Every ounce, every drop, has therefore to be lifted for a height of 20 feet or more before it can be discharged into the Thames. Four large pumping-wells, each 22 feet by 33 feet, receive the great arterial sewer, for on this side one large one, 11 feet 6 inches in diameter, brings the stream of the collective three mains from New Cross to the outfall station. That solids and refuse—kettles, saucepans, broken pots, and the *multa alia* which are committed to the capacious intestines of the London drains—may not pass into the pump, a large iron grating is fixed vertically in front of the pit into which the sewage first enters before running into the pumping-well. Against this grating such heavy and dense materials strike, and fall into the pit, from the bottom of which buckets affixed to a revolving strap scoop the sullage out, and convey it to the surface, where, turning over in their

revolution they empty themselves of their contents into suitable receptacles provided for the purpose under the engine-house. What passes through the grating, then, into the absolute pumping-chamber is the finer and liquid sullage. This is pumped into the reservoir, where a further settlement of the lighter sediments still held in suspension will take place. If the sewage be allowed to go into the Thames, no deposit in the reservoir is wanted, and a very capacious flushing-culvert is provided at its head to sluice out any settlements that take place during the period of rest while the sewage is pent up. If these sediments should have any commercial value they can be extracted by manual labour or by appropriate mechanical means; the reservoir being divided into four distinct compartments, the entering sewage can be debarred by gates from each and any portion. The engine-house now erecting will contain four engines of 125-horse power each, and these can be applied collectively, separately, or in any combination that may be required; the sewage which they will raise from the lowest arterial drain they will pump into an upper sewer above the level of the reservoir, into which it will flow through numerous smaller openings in the side of the upper sewer; and after its periodic repose in the reservoir it will flow out again through other numerous outlets, forming a middle line of sewer between the two we have already mentioned. The following little sketch, not an actual section, but conveying the main principles and features, will render these arrangements more intelligible than words:—*

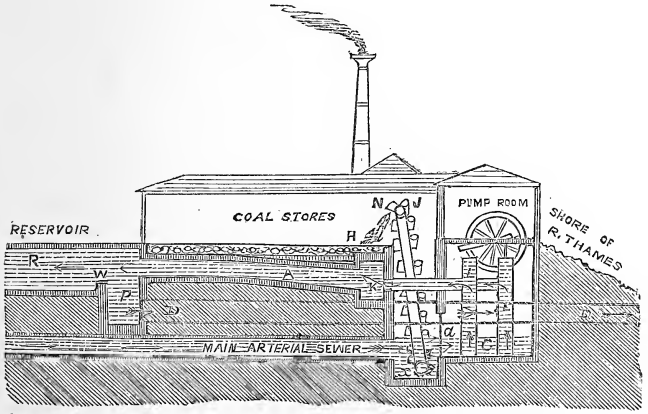


Fig. 8. Plan of the Southern Outfall Pumping-Station and Reservoir at Crossness.

* It is necessary to say, to disarm the criticism by engineers, that none of the illustrative diagrams to this paper are drawn to scale, or from actual plans: they are either from rough sketches made during an inspection of the works in my note-book, or have been in some cases constructed diagramatically, to render principles intelligible rather than to give exact representations.

The sewage arrives by the lowest or main arterial sewer to the pumping-station. It first flows into the pit *x*, where is seen the "Jacob's ladder" (J) of ascending and descending buckets, scooping up the solid refuse at *x* and emptying it as they turn over at N into the receptacles above referred to. The grating for preventing solid substances from passing into the pumping-chamber is shown at *a;* and through the grating the liquid sewage flows on into the pump-well at C. Ascending as the pumps (L L) are worked, the sewage is sent by them into a chamber (K), from which it passes on through the uppermost sewer (A) into the reservoir (R). There it remains until the gates of the middle line of sewer (D D^1) at D are opened, when the pent-up sewage falls over the wall (W) of the reservoir into the penstock (P) and flows out through the middle sewer (D D^1) into the Thames. As the upper sewer is subjected to pressure by the pumping, it is covered over with a considerable thickness of concrete, and the coal stores are built over it so that it may have the additional benefit of the weight of the fuel to serve also to increase its strength and resistance. The brick roof of the reservoir is arched over from parallel lines of piers, and provision is made at every second arch for ventilation. These arches are now being turned; and the manner in which the contractor, Mr. Webster, has executed those portions of these outfall works which are at present completed, is deserving of the highest credit. It is very rare indeed to see bricks laid in such a fine and finished manner. We have now given an outline of the plans of the great metropolitan drainage systems and some general ideas of the works themselves. Into the question of the utilization of sewage it is not our province to enter in this article. For the present, the course adopted is to get rid of the sewage into the river, as far off from the city as possible, and for this purpose the plans of Mr. Bazalgette are most effective and well-considered; they possess, too, this merit, that they can be adapted to any other system which experience may hereafter prove to be worthy of adoption.

NEW INVENTIONS.

MAGNETO-ELECTRIC TELEGRAPHS.—*Mr. W. E. Newton, patentee.*—The leading object of this invention is to enable the operator, by the operation or movement which he makes, to designate or select the character or sign which he desires to transmit, to develope the electric current by which such character or sign is transmitted. The invention consists in the use of a magneto-electric engine, by the rotation of which electric impulses are induced alternately in opposite directions. The electro-magnetic engine is connected by conductors with electro-magnets, the polarity of which is alternately reversed by the alternately reversed impulses induced by the engines. An interposed vibrating permanent magnet or armature at the end of a pendulous lever is, by the alternately reversed polarity of the electro-magnets, when these are combined, caused to vibrate, and by means of pallets and arms at the opposite end of the lever, will actuate an escapement wheel, on the axle of which is an index or pointer, which is made to traverse round and indicate on a circular series of letters, signs, or figures, the particular sign it is desired to transmit to the distant station. This part of the apparatus is connected with a mechanism which, as the operator indicates or designates the characters or signs which he desires to transmit, will set the magneto-electric engine in action, and will thereby develope or generate the electric impulses which will transmit such character or sign. The second part of the invention consists in combining with the electro-magnetic apparatus, or the equivalent thereof, the escapement arrangement above mentioned, whereby to indicate or develope the character or sign transmitted.

ELECTRIC TELEGRAPHS.—*Mr. C. F. Varley, patentee.*—The first part of this invention consists in employing for electric telegraphy, the increment and decrement of electric currents, instead of, as has hitherto been the case, the flow of the current itself. Another part of the invention consists in the use of a test circuit, formed by induction plates and resistance coils, so adjusted to each other as to produce an artificial line possessing the same amount of retardation as the cable itself. Another part of the invention consists in forming a contact piece of metal in the delicate spring contacts of telegraph instruments.

INSULATING COMPOUND.—*Messrs. Hancock & Silver, patentees.*—In this invention, the patentees combine caoutchouc with a milk or gum, the produce of a tree called Sapota Mulieri, or bullet-tree, which is found in British Guiana. This milk or gum possesses similar insulating properties to caoutchouc. They combine this milk or gum with caoutchouc by mastication, rolling, or solution, according to one of the several processes well known among india-rubber and gutta-percha manufacturers.

Surveying and Levelling Instruments.—*Mr. G. H. Birkbeck, patentee.*—This invention has for its object the arrangement and combination of parts so as to form a compound surveying instrument, called a "level-graphometer square," which is capable of executing the various operations which each of the above-named instruments is only capable of performing separately. This improved instrument is composed of a cylinder of brass, or other suitable metal, divided longitudinally with its axis into two equal parts, connected together by a central pin or axis, thus forming two cross-staffs, to each of which "pinicles" are hinged, so as to fold down out of the way when not in use. Between the two semi-cylindrical parts a dial or plate having divisions thereon is fixed and used. When the instrument is employed as a "graphometer," it is mounted, by a screw-pin or otherwise, upon a suitable stand or support. When the instrument is employed as a level, it is suspended by a ring attached to the upper end thereof, and is accurately adjusted perpendicularly by a movable weight, actuated by an adjustable screw attached to the lower end. Sight-holes or openings are formed through the movable semi-cylindrical part of the instrument, through which the divisions on the dial-plate may be seen and read off when required, a fine wire or thread being stretched across each aperture in the direction of the line of sight. Flat plates, connected by a central pin or axis, may be substituted for the semi-cylindrical parts before described, by which the construction of the instrument will be simplified, but its form will not be so elegant. The divisions on the dial-plate are in sections of five, or other suitable number of degrees, so that the instrument acts not only as a "square," but also admits of small angles being taken, as with the "graphometer."

Barometers or Instruments for Measuring Altitudes, or the Pressure of the Atmosphere, &c.—*Mr. J. E. Blackwell, patentee.*—This invention relates to a novel mode of constructing these instruments, so as to render them portable, and exceedingly sensitive and accurate. These objects are effected in some of the improved instruments by a combination of several separate improvements; but, in others, some only of the improvements are comprised. In all the improved instruments, however, the variations in pressure are ascertained by means of elastic vacuum chambers, as in the ordinary aneroid barometer; and the patentee finds it convenient to employ four or more elastic chambers arranged in groups or sets, so that the inequalities of pressure, or inaccuracies of action in any of the several chambers, shall be compensated by the others. In all the instruments these vacuum chambers are directly attached to or connected with helical or other springs, the power or elastic force of which has been previously ascertained with great care, and which reciprocate the expansion or compression of the chambers accordingly as they are acted upon by diminished or increased pressure.

Watches.—*Mr. F. B. Anderson, patentee.*—This invention consists in constructing those parts of watches and other time-keepers known as hollow fusees, and as stops to prevent the main-spring from being overwound, as hereafter described. The patentee forms a disc on the arbor, by preference, in a piece with it, and sinks a recess in the outside of the fusee brass, into which the disc is fitted and secured by soldering or other

attachment. He forms a square on the back of the arbor, to receive what he terms a gatherer or stop, which works inside a steel split ring, formed with three or more teeth, and with an abutment on the inside thereof. As the watch is wound, the gatherer takes round a tooth at every complete revolution, until the spring is wound up, when the gatherer comes in contact with the abutment, and prevents overwinding. The split-ring is encased in a box, fastened on the back of the pillar plate.

Clocks or Timepieces.—*Mr. H. Jorns, patentee.*—This invention is intended to obviate the necessity for winding up clocks or timepieces periodically. The patentee proposes to effect this object through the agency of the variations in the temperature of the atmosphere, which are constantly taking place both inside and outside of dwelling-houses, and to employ the draught or current of air, caused by such changes in temperature, to set in motion certain mechanism to be connected to the ordinary mechanism of clocks, and by these means to produce a power sufficient to wind up a clock. By this invention a great part of the weight at present necessary to keep the going parts of a clock in motion may be dispensed with.

Pictorial Foregrounds and Backgrounds for Photographic Portraits.—*Mr. T. Bennett, patentee.*—In taking photographic portraits or pictures in which it is desired to adopt suitable backgrounds, foregrounds, or perspectives, it has been hitherto the practice to use a painted canvas, descending to and terminating at the floor or standing-place of the apartment. According to this invention, the patentee uses a canvas (or equivalent substance) suspended or secured upon a roller or rollers, with pulleys and cords by which the canvas can be raised or lowered. This canvas is of sufficient length to allow it to be brought down to the floor, then stretched along the same, and kept in position (if desired) by catches or grippers, so that the persons or objects to be portrayed may stand upon a part of the canvas. The background, foreground, or perspective, which is to remain perpendicular, or nearly so, is to be painted or depicted in the ordinary or perspective manner, and that part of the canvas which is to lie upon the floor is to be painted so as to have the same convenient effect as the upright part, and so as, imperceptibly, to "run into" the same. For this purpose he has hitherto adopted the plan of first painting the upright part, and fitting the same to a corresponding position to that in which the same is intended to be used, and then stretching the horizontal part upon the floor, drawing lines or objects by the aid of the camera.

Minute and Magnified Photographic Pictures.—*Mr. A. F. Eden, patentee.*—This invention consists, first, in adapting to the object end of the camera a small removable box or dark chamber, in which is placed the glass plate with the sensitive surface, when it is desired to obtain a minute photographic picture. In order to obtain an enlarged or magnified picture of a microscopic object, the latter is placed in the small removable dark chamber, and light is admitted throughout a proper aperture, and allowed to pass through the object, and also through an arrangement of lenses which will throw the magnified image on to a sensitive surface placed at the proper focal length behind. From this explanation it will be under-

stood that this small box or dark chamber performs a double office, depending upon the nature of the operation to be performed. To facilitate the operations of the photographer, this box or dark chamber is made to work in guides or dovetailed grooves, so that it may be easily removed from the camera and replaced when required. Another improvement consists in placing behind the lens, and in front of the negative, a stop with a very small aperture, in contradistinction to the large apertures of the ordinary stops. The patentee finds by experience that, for producing good results in making micro-photographs, the aperture of the stop should not exceed the fiftieth part of an inch in diameter, and that, in good lights and under favourable circumstances, a much smaller aperture may be advantageously employed. Another improvement consists in adapting to the object end of the camera a focussing lens, which is screwed on to the small removable box or dark chamber, and is adjusted by means of a sliding tube.

PHOTOGENIC PICTURES.—*Mr. W. Clark, patentee.*—This invention relates to a photogenic process, whereby a positive image may be obtained direct from a positive by the employment of ammoniacal salts, combined with the organic matter, and also by the precipitation of the following metallic solutions, viz.: salts of silver, copper, iron, nickel, mercury, gold, palladium, platina, lead, or tellurium, which are precipitated by means of hydro-sulphates of ammonia, potash, or soda. The salts of silver, bismuth, or lead, are precipitated by means of hydro-sulphuric acid, and the salts of mercury by hydro-chlorate of tin. The salts of bismuth may also be precipitated by means of nutgall, gallic or tannic acids, and the salts of iron by means of the same agents last mentioned. The inventor takes, for example, the sulphate of iron precipitated by means of tannic acids.

STEREOSCOPIC APPARATUS.—*Mr. H. Swan, patentee.*—According to this invention, the patentee combines stereoscopic pictures with pieces of glass or transparent crystal of suitable form, in such manner that the pictures, which are in fact depicted on the exterior of the glass or crystal, or on surfaces placed in contact with, or at a small distance from them, shall produce an image apparently solid and imbedded in a glass or crystal.

STEREOSCOPES.—*Mr. S. Russell, patentee.*—In performing this invention, an instrument is constructed in the form of a box, suitable for containing when out of use a number of stereoscopic slides or pictures. The instrument is closed by a sliding or other suitable cover when out of use, and on the interior and against one side mirrors are fixed. The bottom of the box may be made to slide also, so that when in use a stereoscope may be open both at top and bottom. The lenses or eye-pieces are fitted in apertures in the lower part of the opposite side of the box, this part of the side being suitably inclined to the plane of the mirrors. The stereoscope pictures or slides are, when about to be observed, placed in suitable grooves or holders opposite to the mirrors, and on the side where the lenses or eye-pieces are applied, and are held in a position inclined to the plane of the mirrors. By this arrangement no reflector is required to throw light on the picture, but the light falls directly on it, so as to illuminate it thoroughly.

MANUFACTURE OF PAPER.—*Mr. C. E. Amos, patentee.*—In carrying out this invention, the knots and other extraneous matters which accu-

mulate below the straining surface or knotter-plates are drawn out or removed by a pump, or other analogous contrivance, and are conveyed into an ordinary knotter, which is to be used for the separation of such knots and extraneous matters from the fine pulp which may be drawn out or removed therewith. The fine pulp will then be allowed to flow back into the other or first knotter beneath the knotter-plates, through which it will pass and be conducted into the paper machine, while the knots will remain on the top of the knotter-plate of the second or ordinary knotter, and may be readily removed therefrom by a skimmer. By this arrangement of parts, there will be but little necessity for stopping the machinery to cleanse the knotters, and the work may therefore proceed uninterruptedly.

Manufacture of Paper.—*Mr. R. H. Collyer, patentee.*—According to this invention, the patentee subjects the materials to showers of hot water and showers of alkaline liquor used alternately, and to superheated steam —that is to say, he heats the materials at intervals with showers of hot water, and at the same time acts on the materials with superheated steam, and between the showers of water he heats the materials with showers of alkaline solution or liquor, still continuing to inject superheated steam. Instead of superheated steam, he sometimes uses hot air, or superheated steam and hot air together.

Manufacture of Paper.—*Mr. W. Astrop, patentee.*—This invention consists in the employment of fibrous portions of the roots of parsnips, carrots, and turnips of all kinds, and of the roots, stems, and stalks of the beet, mangold-wurtzel, chicory, and rhubarb plants; also of the fibre of the cocoa-nut and leaves of the orange plant, and flags or reeds; also horse and cattle manure, for the manufacture of "half-stuff" and pulp to be used in the production of paper and cardboard; the substances and materials hereinbefore enumerated being employed either separately or in combination with each other, or with any of the ordinary pulps now used in the manufacture of paper and cardboard.

Manufacture of Paper.—*Mr. R. H. Frith, inventor.*—This invention consists in reducing peat or turf-bog into a pulp with chloride of lime, or by any other chemical bleaching process, and afterwards manufacturing such pulp into paper in the ordinary way.

Manufacture of Dyes.—*Messrs. R. T. & R. Monbeith, patentees.*—The patentees claim the production of red and violet colouring matters by the decomposition of hydrochlorate or sulphate of aniline, or its analogues, by heat, whether those substances are used by themselves or mixed with aniline or its analogues, and whether either of the above mixtures is heated alone, or after it has been mixed with sand or any other finely-divided substance as aforesaid. Also the use of salts of ammonia for the purpose described. Also the admixture with the colouring substances (as described) of sand, gelatinous silicic acid, fluoride of calcium, or any other finely-divided substances, not liable to act otherwise than mechanically upon the substances employed in the process described. And also the production of brown colours by the decomposition of salts of aniline, or its analogues, by heat, as described. Whenever hydrochlorate of aniline or aniline is mentioned, the hydrochlorate of aniline of commerce, or aniline of commerce, is intended.

PRODUCING COLOURS.—*Mr. A. P. Price, patentee.*—Here the inventor takes a compound or combination of aniline, consisting of aniline combined in equivalent proportions with any of the following acids; namely, acetic, valerianic, lactic, benzonic, cinnamic, tartaric, and oxalic acid, such compounds being either obtained by, or resulting from, direct combination of equivalent proportions of acid and aniline, or obtained by means of, or resulting from, double chemical decomposition. He mixes any one of these compounds or combinations, so resulting or obtained, or mixtures of them, with the substance known in Germany and France as fuchsine, and corresponding with those products obtained from aniline know in this country as magenta and rosaniline, and he heats the same together by preference at a temperature of from 150° to 190° centigrade, until the desired blue colour free from violet is produced.

GREEN COLOURING MATTER.—*Mr. W. Clark, patentee.*—This invention consists in preparing a green colouring matter from aniline, which is soluble and suitable for dyeing and printing purposes, by means of a combination of reducing agents, such as hydrates and soluble hyposulphites acting on acidulated solutions of salt and rosaniline, or on the blue or violet compounds derivable from the same.

FIXING COLOURS IN PRINTING CALICO.—*Mr. R. Penney, patentee.*—This invention relates to fixing those colours employed in printing calico and other fabrics which are produced by means of catechu. The patentee employs a solution made in the following manner, and treats the catechu colour therewith:—he takes of the ordinary chloride of calcium of commerce (which may be made by saturating spirits of salts with quicklime in a powdered state) three, four, five, or other number of parts, and mixes therewith one or other required number of parts of nitrate of copper, at 80 deg., or other required strength, or of chloride or muriate of copper, either instead of nitrate of copper, or in combination therewith; such admixture is to be made whilst the calcium is in a heated state, and then filtered for use. These parts must be varied according to the depth, shade, or tone of colour to be treated.

MANUFACTURE OF SULPHATE OF SODA.—*Mr. R. A. Brooman, patentee.* When a mixture of coal, sulphuret of iron, and chloride of sodium is heated in the presence of air, sulphate of soda, oxide of iron, and chloride of iron are formed; the proportion of these different bodies varies with the quantities of the substances above named forming the mixture, as also the state of division when used. This invention consists in manufacturing sulphate of soda by reducing to a powder the fuel (charcoal, coal, coke, or other fuel), the natural or artificial sulphuret of iron, and the salt, and in mixing these substances in certain fixed proportions.

PURIFYING, BLEACHING, AND REFINING OILS.—*Mr. S. White, patentee.* This invention consists in introducing the oil, or oily or fatty matters, with a re-agent calculated to eliminate or separate the impurities contained in them, into a vessel having small orifices or perforations in its sides, and revolving rapidly within a larger vessel, which is open to the atmospheric air, so that when the smaller vessel revolves, the oil, or oily or fatty matter combined with the re-agent which is used with it, will be projected through the orifices in the sides of the smaller vessel in thin streams,

which will be driven against the internal sides of the larger vessel, and thereby be scattered and subdivided, and will thus be presented in a partially atomic state, or in a dewy form, to contact with the light and the atmospheric air, by which exposure of the oil, or fatty or oily matters, in a minutely subdivided state, the light, and particularly the oxygen of the atmosphere, produces an improved purification of such oil or fatty matters.

Preserving Provisions.—*Mr. G. Davies, inventor.*—The first part of this invention consists in causing a current of electric fluid to pass through the cases containing the provisions after they are finally closed up. The electric fluid being made to pass along a fine iron or other metallic wire through the case, causes the wire to become red-hot, and consume the oxygen. Another improvement consists in placing inside the case, and in connection with the iron wire, any known chemical agent (such as common sulphur, for instance) which, in its ordinary state, has no particular affinity for oxygen, but which, upon becoming ignited (by means of the electric wire above referred to), evolves any gas (sulphurous acid gas, for instance) which will absorb, destroy, or convert into a harmless gas the oxygen which is contained in the case, and which it is desired to get rid of; or the sulphur or other agent may be ignited by any other convenient means. A further improvement in connection with the use of electricity for this purpose is as follows:—After the case has been closed, a sufficient quantity of hydrogen gas is to be introduced therein to form (with the oxygen that may be in the case) an explosive mixture or gas, and this gas is to be then ignited by passing a current of electricity along a metallic wire through the same, and thus all traces of oxygen will be destroyed.

Lighting Theatres, &c.—*Mr. E. B. Keeling, patentee.*—This invention is intended to be applied to the lighting of halls, theatres, and other buildings, and relates to the diffusion of intense light, and to the prevention of shadows. The patentee takes an electric-light, a lime-light, or other source of intense light, and places it in some elevated spot above the space to be lighted. Under or before, or part under and part before this light, he suspends or fits a plain white, tinted, or coloured curtain or screen, and again, in some instances, he places under or before, or part under and part before, a ceiling of glass or other transparent medium. By these means he removes the obstacles that have hitherto prevented the successful application of the electric, lime, or other intense lights to the lighting of the interior of large rooms and public edifices, and that have also all but confined these sources of light to the position of mere scientific curiosities. It is well known that the chief obstacles have been the intense brilliancy of the lights, their unpleasant white or ghastly hue, and the dense black shadows thrown by them. The first, however, gives so far a margin that the medium of the curtain absolutely utilizes the objection by the sacrifice of brilliancy, but by the complete diffusion of the rays. The second obstacle is overcome by the tint or colour of the curtain or screen, giving any hue most desirable to assimilate with any of the lights now usually employed, whether it be that of gas, of any description of oil-lamp, or that of any wax or other candles. The relative use of the curtain

or screen to the source of light is the same as that of the clouds to the sun.

Manufacture of Candles.—*Mr. R. A. Brooman, patentee.*—The objects of this invention are to obtain a brighter and more uniform light, and to prevent guttering in candles. The invention consists in the employment of a hollow or tubular wick to produce a current of air to the centre of the flame. For candles intended to be burnt in sockets or holders which will not allow a current of air to pass through the bottom of the candle, the inventor forms an aperture or passage through the side of the candle above the socket or holder, and communicating with the interior of the wick, During the manufacture of candles, according to this invention, a spindle or rod is passed through the wick to keep it open.

Treatment of Gas.—*Mr. J. Leigh, patentee.*—This invention consists in the subjection of the gas that is obtained in the distillation of coal, cannel, bituminous shale, bog-head, mineral oils, petroleum, or other combustible substances, to the action of nitric acid, or of a mixture of nitric and sulphuric acids, by which nitro-benzole and certain other compounds are obtained, and in the course of which certain substances are removed from the gas employed.

Manufacture of Gas.—*Mr. E. B. Wilson, inventor.*—This invention consists in the manufacture of gas from oil, by placing in a suitable vessel containing the oil a coil of piping, pipe, or pipes, through which the inventor passes hot water, air, or steam at such a temperature as shall generate gas from the oil contained therein, which vessel may be large enough to be but partially filled with oil, leaving the remaining space for gas ; or a separate receiver with purifier may be connected.

Lamps.—*Mr. W. C. Wilkins, inventor.*—To a lamp constructed with a reservoir in its stem or base to contain the matter to be burned, and means for forcing up such matter for consumption, the inventor applies between such reservoir and the burner a small vessel of porcelain, glass, or other suitable material that will not freely conduct heat up to the burner, and he applies cork, or other suitable non-conducting material, between the upper parts of a receiver and the burner tubes, acting as a receiver for, or feed to, the lower part of the wick, and of the fluid being consumed. This receiver has an overflow for surplus fluid to flow back into the reservoir below. He also applies an internal hollow cone, and an external tubular deflector, the upper or deflecting edge thereof being turned inwards, and at or near the level of the wick tubes ; which external deflector he prefers to be of glass, so as to intercept the rays of light as little as possible ; over these he applies an external chimney.

Signal Lanterns.—*Mr. J. Price, patentee.*—The peculiarity of this invention consists in combining the parts of a lantern so that, at one time (that is, when a boat is at anchor), the lantern will show a white or bright light all round, and when the boat is in motion the part of the lantern which is glazed round with white glass may be covered interiorly or exteriorly with a screen, consisting of three parts or divisions, one being opaque, one red glass, and the third green glass, so that the light in the lantern will be only thrown forward through the red and green screens,

whilst the light will be stopped from being seen at the third or back side of the lantern.

Reflectors.—*Mr. M. Hackforth, patentee.*—This invention relates to manufacturing shades or reflectors for lamps or lights of all kinds of porcelain or china. These materials afford an economical reflector, which can be cleaned by simply washing with water.

Revolving Shutters.—*Mr. W. Francis, patentee.*—These improvements consist in so constructing the laths or plates of revolving shutters, that they may revolve in either direction round the roller to which they are attached. The patentee forms a groove in the bottom or lower edge of each lath or plate, and along the entire length of each lath or plate of which the shutter is composed (except the bottom lath of each shutter), and he constructs the upper edge of such lath or plate thinner than the lower edge thereof, to fit into the groove in the lower edge of the lath or plate immediately above it. He then unites the several laths or plates by belts, webs, chains, cords, or wires, passed through holes or mortises in the breadth of each lath or plate in the usual way.

Cannon and Projectiles.—*Mr. B. F. Bates, patentee.*—Cannon constructed according to this invention have a hole formed through the breech smaller than the bore, and parallel and concentric with it. Each projectile is provided with a long rod or bar which, in loading the cannon, is passed through the hole in its breech. At the front end of the rod there is an enlargement or head, which, however, is smaller than the bore ; this head may be solid or otherwise ; and behind this enlargement a loose disc is placed, which fits the bore accurately. The periphery of this disc may be made of soft metal, and may have lubricating material combined with it. The rod at the rear end of the projectile is, by preference, polygonal in section, with each of the sides winding spirally around the rod from end to end of its length, as though the rod were twisted. The hole in the breech end of the cannon is formed to fit and correspond with the bar, so that, when the piece is fired, the projectile, in addition to being propelled forward, will, at the same time, be caused to revolve on its axis. The loose disc behind the head of the projectile, by preference, does not rotate with the projectile ; but the rod of a projectile turns in a hole in the disc. As soon as the projectile leaves the gun, the resistance of the gun will cause the disc to slip off the bar at its near end ; or the disc may be made to separate into two or more pieces as soon as it leaves the gun. If desired, the hole through the breech end of the gun may be closed as soon as the rear end of the projectile passes out of it, by means of a sliding piece pressed forward for that purpose by a spring. The hole in the breech end of the gun may be provided with a close-fitting plug ; the gun can then be used either to propel a shot, such as above described, or, when the plug is fixed in the hole, the gun may be used as an ordinary smooth-bore gun.

Breech-loading Firearms.—*Mr. A. Albini, patentee.*—This invention consists in the arrangements hereafter described for opening the breech-end of breech-loading firearms, for the introduction of the charge and for securely closing the discharge. For this purpose the patentee prolongs the breech-end of the barrel beyond the discharge-chamber, to a length somewhat greater than that of an ordinary cartridge. The upper side of

the prolonged part is open for a sufficient length to admit of the introduction of a cartridge. Upon the prolonged part there is a cap connected with a screw-plug, which plug screws in the said prolonged part and closes it. A rod passes through a hole in the centre of the said screw-plug, and terminates in the prolonged end of the barrel with a conical plug or closer, which accurately fits the conical end of the charge-chamber. The rod of the plug or closer is made semi-cylindrical, or of a prismatic figure, through the greater part of its length, its outer end being cylindrical and of small diameter. The hole in the screw-plug, through which the rod of the closer works, is of the same figure as that part of the rod which passes through it. The projecting end of the rod is provided with a button or knob, by which the said rod can be pushed forward and withdrawn. Where the rod is pushed home, and the plug or closer made to close the end of the barrel, the screw-plug is turned by means of a handle attached to it, and the hole in the said screw-plug is made to cross the end of the rod, and a shoulder on the said rod is thereby supported by the screw-plug, and the plug or closer firmly fixed to its seat. The firearm is then ready for discharge. To recharge the firearm after firing, the screw-plug is turned a semi-rotation, so as to bring the opening in the screw-plug coincident with the rod of the closer. The closer can now be withdrawn from the breech-chamber and a fresh cartridge introduced.

Powder-Flasks.—*Mr. G. Haycraft, patentee.*—These flasks the patentee makes with a hollow cylindrical screw stopper, and with a screw-thread formed upon the outer side of it. This hollow cylindrical stopper closes the mouth of the flask, there being a corresponding female screw formed in the neck thereof; the stopper is closed at the other end by a head-piece; it serves, when the flask is open, as a measure for the powder, it being made to contain one charge thereof.

Propelling Vessels.—*Mr. A. Johnston, patentee.*—This invention relates to a method of propelling vessels by means of an improved propeller, consisting of one or more pairs of submerged cylinders, fitted with pistons of the form hereinafter described. The patentee makes use of one or more pairs of these cylinders and their pistons, and he places them, water-tight, below the light-load water-line in the stern or other suitable part of the ship. The cylinders and their pistons are used in pairs, each pair of pistons by the piston-rods being connected to each other by means of a rocking-beam or beams placed inside the ship. By reason of being connected to this rocking-beam the pistons are balanced and kept in their relative positions. The propelling pistons (which he calls the water-pistons, to distinguish them from the steam-pistons) are formed with projections or noses, which extend from the piston-head and packing of the water-pistons towards the mouth or open end of the water-cylinders. These projections or noses must be made of a size sufficient to fill up the whole area of the water-cylinders when the pistons are drawn back, leaving just space enough to avoid friction or rubbing against the inner surfaces of the said water-cylinders, and the ends of the projections should be slightly dished or hollowed out, so as to enable them to take a better hold of the water. The projections may be made of cast-iron, and should be made hollow, but they must be made of such weight as to be equal or

thereabouts to the weight of water which they displace, so that when the pistons are extended to the full length of the stroke there may be no strain on the water-cylinders.

Sheathing Ships.—*Mr. W. H. Muntz, patentee.*—This invention consists in attaching sheets of india-rubber, or other insulating or "anti-galvanic" material to the vessel's side, and metal sheathing to the insulating material, by means of marine glue, or such other cement or adhesive substance, as will resist the action of sea-water, instead of nailing or riveting the same.

Treating Iron Plates for Ship-building.—*Mr. A. Ellissen, inventor.*—In carrying out this invention, the inventor treats iron sheeting or plate with cyanide of potassium or potash, or other material of equivalent effect, to render the same useful for shipbuilding, and thereby protecting ships or other marine constructions against marine animals and marine plants.

Apparatus for Tuning Pianofortes.—*Mr. R. A. Brooman, patentee.* In order to tune two strings, or make two strings agree, they must be of the same nature, and possess homogeneity of sound; and to obtain this result it is necessary, first, that they be made to vibrate simultaneously; secondly, that the vibrations run together in the same sounding-board; thirdly, that they follow the same circumvolutions, and that they be reverberated by the same surfaces. The apparatus which forms the subject of the present invention fulfils these conditions. The inventor arranges a sonometric string parallel to the strings of which it is the type; it rests on the same bridge and acts on the same sounding-board. The longest string in the pianoforte is supported on a movable nut, guided in a longitudinal direction by a register for indicating externally the sound the type of which is required. The string, lengthened or shortened according to the proportions of the sonometer, by means of an additional pedal, gives successively the typical sound in the score to be produced. Thus, to tune an instrument, the typical string and the string to be tuned are simultaneously struck, one with the foot (because the pedal moves a hammer), the other with the left hand, while the right acts on the peg of the second string to raise or lower it in unison with the first; the tuner proceeds with these strings as if they belonged to the same key. This tuning apparatus may be fitted inside or outside the pianoforte.

Thrashing Machines.—*Messrs. Clayton & Shuttleworth, patentees.*—According to this invention, the grooves or channels are formed parallel to each other longitudinally along the face of each beater; not, however, in straight lines, as heretofore, but in serpentine lines. It is preferred that each beater of the drum of a thrashing machine should be formed with three serpentine grooves. The whole of the grooves or channels, although they are parallel to each other, and formed in a longitudinal direction along a beater, do not (in consequence of a beater having parallel sides) all pass from end to end of a beater, but only some of them, whilst others only extend along a comparatively short length of a beater.

Sewing Machines.—*Mr. A. Prince, patentee.*—This invention embraces certain mechanical arrangements whereby the fabric to be operated upon

is moved along the needle-plate by the motion of the needle-bar, such motion being obtained by screws or pins operating upon projections of metal, glass, or other hard substance, each presenting either an inclined plane or a curvilinear surface to the pins or screws, the projections being attached to and projecting from the front plate of the machine head, and set at the required angle. The invention also consists in the substitution of a needle-plate of glass, in lieu of metal, for allowing the operator to inspect the progress of the work ; and also in an improved pressure foot.

Omnibuses.—*Mr. J. P. Bath, patentee.*—It is desirable that omnibuses should be rendered equally available for travelling upon rail or tramways or common high roads, and these improvements have that object in view. The invention consists in suspending, by joints, to the underside of the "fore carriage" two short pendulous arms, to the lower ends of which are attached axletrees running parallel with the main axletree on the outside of these arms, and carrying thereon vertical revolving face-plates, to the front of each of which is secured a disc, annular ring, or wheel, which, extending a short distance beyond the ordinary running wheels, acts as a flanch for keeping the bearing wheels on the rails. The inner ends of the axletrees on the inside of the pendulous arms, the inventor prefers, for the sake of strength, to bend upwards, and he attaches them to the centre of the main axletree by a suitable joint or joints. When the guides are in use they are held in position by india-rubber or helical springs attached on each side to the lower end of the pendulous arms, and to the ends of cross-beams or arms extending across the main axletree. When the carriage is required to run on an ordinary road, the guides are drawn up—by preference in a backward direction—by a bridle, chain, or cord and small windlass, or other mechanical equivalent, worked by the driver or other person.

Securing Corks in Bottles.—*Messrs. Miller & Struthers, inventors.* In carrying this invention into practice, under one modification, two holes are formed in the neck of the bottle or jar during the progress of manufacture, or while the bottle or jar is in a sufficiently softened state to admit of the material being easily pierced. These holes are by preference in the rim which forms the mouth of the vessel, bottle, or jar, and they are made opposite to one another, so that when the vessel is filled, and the cork or stopper is inserted, a short length of wire, a pin, or other retaining medium, may be easily passed through the cork.

Damping and affixing Postage-Stamps.—*Mr. T. Gordon, inventor.* This invention comprises the following arrangement of parts :—The inventor has a reservoir for water incased in wood or metal forming the base ; in this reservoir he inserts a cotton with sponge attached, communicating by a small tube with a perpendicular square box or cylinder on the top of the base, of which there are two—one on the left and one on the right hand side—elevated by four small springs, so as to form openings for the reception of the letter. The left hand box or cylinder contains the sponge ; it has also a piston working in a sliding cylinder, which, when pressed,—the letter being placed in the opening formed as aforesaid—damps the corner of the letter ; the right hand box or cylinder, which is

portable, contains the stamps; by passing the letter from left to right, and pressing the piston as aforesaid, the stamp is fixed firmly and securely to the letter.

Tobacco-Smoking Appliances.—*Mr. W. A. Little, inventor.*—In performing this invention the inventor prepares a conical or other shaped tube of paper, tobacco-leaf, or other suitable substance, and fills it with a filtering material. Into one end of this tube he inserts the "butt," or mouth-end of the cigar, attaching it in that position by gumming or otherwise, securely binding it previously to its sale; or he prepares the filtering tube so as to be saleable and portable as a separate article attachable to the cigar by the person about to use it. In the latter case, the inner surface of the end of the tube intended to receive the cigar may be coated with adhesive matter, so that by wetting the end of the cigar it may adhere on insertion. As a filtering material he uses charcoal powder, cotton, wool, flax, hemp, or other suitable powdered or fibrous material, or simply a roll or strips of a suitable kind of cloth or coarse paper. These materials may be used separately or combined, and may, if desired, be impregnated with perfume, and with chemicals possessing affinity for the empyreumatic impurities of the tobacco-smoke.

Tobacco-Pipes.—*Mr. E. Strangman, patentee.*—According to one modification for carrying out this invention, the patentee makes the pipe with a movable thimble, with a flange at the top, and perforated at the bottom, such thimble being placed in the bowl, and intended to contain the tobacco to be smoked; he fills the space between the thimble and the bowl of the pipe with a suitable filtering and absorbent material, so that the smoke in passing from the ignited tobacco to the mouth of the smoker is compelled to pass through the filtering and absorbent material, and thus becomes purified.

Book-Holders.—*Mr. J. J. Lemon, patentee.*—These improvements in the construction of book-trays or holders have for their object the holding in position of a series of books, and their conveyance from place to place. The improvements consist in forming a series of levers, springs, and guide-rods, by means of which the slide or slides and flaps of the tray can be opened for the purpose of inserting or removing books. For operating on double slides, the levers are formed somewhat in the shape of a pair of scissors, and jointed in a similar way by a pin passing through the slide or edge of the tray, their handles extending outside the tray. Attached to the inner ends of these levers are rods working in slots at the under side of the tray, and moving the slides accordingly. In order to bring the slides back after the removal or replacement of a book, springs are attached from two corners of the tray to these levers. These springs may consist of spiral wire, flat curvilinear steel, or other known form of spring, suitable for the purpose; but for a single-acting slide only one lever will be necessary with one spring attached.

Anti-Garotte Knives.—*Messrs. J. S. & S. Hancock, inventors.*—This knife is made with two dagger-blades, one at each end, both acted upon by one spring, which locks them when in the open position, the blades being reseated, when it is required to close them, by raising the end of the spring out of the notch in the blade. Or a catch may be used, acted on

by the spring, and released by pressing on a small projection. The guards at each end of the handle, instead of being fixed to the scales, and projecting at right angles thereto, as is usually the case (and which makes the knife bulky and inconvenient to be carried), are fastened by pins to the blades close to the ends of the scales, and as the blades are closed, the guards close also, spontaneously turning upon the pins, and lie along the blades parallel to the scales, and quite out of the way, but spring into their former cruciform position as soon as the blades are opened.

Metallic Pens.—*Mr. R. Knox, inventor.*—According to this invention, it is proposed to form the pens either of steel, gold, silver, or other metal or alloys suitable for the purpose; and instead of pointing or nibbing one end of the pen only, the inventor forms a nib at each end. Thus each end of the pen may be made with fine points, or one end fine and the other coarse; or, when desired, one point may be extra coarse for engrossing.

Machinery for Preparing Dough.—*Mr. E. Stevens, patentee.*—According to this invention, a mixing-vessel is employed, made by preference of sheet-metal, galvanized or enamelled, or cast-iron may be used. The vessel is mounted on wheels, and thereby made portable. One of these wheels is a pivot-wheel, and has a handle connected to it, by means of which the vessel can be drawn from place to place and readily guided. The bottom of the mixing-vessel is made semicircular interiorly, and double, to contain in the space between the two parts warm water to facilitate fermentation. It should be fitted with a gauge and thermometer. Instead of using water to warm the mixing vessel, it may be warmed by steam, hot air, &c. In addition to this mixing-vessel the patentee uses a fixed frame, consisting of a bed-plate and two standards suitably tied together, and at such a distance apart as to receive the mixing vessel between them; suitable turn-buttons or clumps are used for securing the mixing vessel in this position. To effect the mixing of the dough, a horizontal cranked axis or bar, with inclined toothed stirrers upon it, is employed. The toothed stirrers may be round, or rectangular in cross section, and can be varied in form. The cranked axis or bar is of sufficient length to be able to be placed in the mixing-vessel, and of such form, that when caused to revolve, it passes just clear of the sides and bottom of the mixing-vessel.

BOOKS OF THE QUARTER.

THE NATURALIST ON THE RIVER AMAZONS.*

IF we are ever to arrive at a clear solution of the mystery which now involves the subject of the origin of species, or if any satisfactory generalization regarding the supposed development of new beings, not only morphologically but physiologically distinct from those that have existed before them, is ever to be framed, most assuredly the observations of those who have given years of unremitting attention to the study of the characters of animals, will have much to do with it. And since the framing of exact laws may be regarded as the primary object of all philosophic students of science, the highest meed of praise is due to the man who, having devoted, one may say, a quarter of a life-time to the collection and collation of facts, generously and without reserve presents us with the fruits of his labours,—supplies us, in fact, with the very materials which as zoological legislators we required. To this category belongs the author of the volumes now before us. Mr. Bates, whose character as an entomologist is familiar to all our readers, has here presented us with the results of eleven years' explorations in the wild and little-known regions of tropical South America. The book is written in a terse and pleasing style, devoid of that literary display and indulgence in scientific technicalities which render such works unpalatable to the general reader, and moreover is elegantly and profusely illustrated, and is, as regards its mere mechanical features, a credit to its publisher. The first volume describes the author's adventures in the country of the Lower Amazons, from Pará to Barra and Rio Negro, and his various tracks may be traced along the valuable map which is appended to this portion of the work. The general contour of the country, the characters of its vegetation, and the political and polemical institutions of its human inhabitants have not escaped the notice of Mr. Bates, who, however, has given most of his attention to the nature of the fauna, and the lines of distribution of the animals included in it. The keenness of his powers of observation appears to rival even that of the great Humboldt, for we can hardly conceive of the existence of anything in the vast Amazon region which has not in some manner been alluded to; suffice it to say that no less than 14,712 distinct species of vertebrates and invertebrates were examined, of

* "The Naturalist on the River Amazons." A Record of Adventures, Habits of Animals, Sketches of Brazilian and Indian Life, and Aspects of Nature under the Equator, during Eleven Years of Travel. By Henry Walter Bates. 2 vols. London: Murray.

which about 8,000 were *entirely new* to science. The habits of the animals examined have been closely watched. It has been often asserted that certain species of Mygale were addicted to the destruction of the smaller birds, but the statements made, required confirmation: this has now been given by Mr. Bates, who writes:—"In the course of my walk I chanced to verify a fact relating to the habits of a large hairy spider of the genus Mygale, in a manner worth recording. The species was *M. avicularia* or one very closely allied to it. The individual was nearly two inches in length of body, but the legs expanded seven inches, and the entire body and legs were covered with coarse grey and reddish hairs. I was attracted by a movement of the monster on a tree trunk; it was close beneath a deep crevice in the tree, across which was stretched a dense white web. The lower part of the web was broken, and two small birds, finches, were entangled in the pieces, they were about the size of an English *siskin*, and I judged the two to be male and female. One of them was quite dead, the other lay under the body of the spider not quite dead, and was smeared with the filthy liquor or saliva exuded by the monster." Gastronomic science too has not been neglected by our author. On one occasion having exhausted his supply of fowls, and being unwilling to eat the stale and stringy salt fish of Caripi, his 'servant provided him with a dish of ant-eaters' flesh, which he thus describes:—"The meat was stewed and turned out very good, something like goose in flavour. The people in Caripi would not touch a morsel, saying that it was not considered fit to eat in these parts; I had read, however, that it was an article of food in other countries of South America." The resemblance of certain invertebrate animals to birds, is also indicated, and is illustrated by allusion to the humming-bird moth, which simulates so well the bird after which it is named, that, as Mr. Bates remarks, "the natives firmly believe that one is transmutable into the other." By far the most important portion of this volume is that which relates to the localization of certain lepidopterous species, which have been carefully investigated by the author. Treating of *Heliconius melpomene*, he writes, "This elegant form is found throughout Guiana, Venezuela, and some parts of New Granada. It is very common at Obydos, and reappears on the south side of the river in the dry forests behind Santarem, at the mouth of the Tapajos. In all other parts of the Amazons valley it is entirely absent. . . . . Another and nearly allied species, however, takes its place in the forest plains, namely, the *H. thelxiope* of Hübner." These two species are of the same size, and have exactly the same habits; but the *H. melpomene* is simply black with a large crimson spot on its wings, whilst the other is rayed with black and crimson, and possesses yellow spots in addition. "There are, as might be supposed, districts of forest intermediate in character between the drier areas of Obydos, &c., and the moister tracks which compose the rest of the immense river valley. At two places in these intermediate districts, namely, Serpa, 180 miles west of Obydos, and Aveyros, on the lower Tapajos, most of the individuals of these Heliconii which occurred were *transition forms, between the two species.*" A very plausible objection might be offered as to the *real* specific character of these forms, to the effect that they were mere hybrids of the two known species; but Mr.

Bates asserts that although the two "come in contact in several places where these intermediate examples are *unknown*, I *never* observed them to pair with each other. Besides which, many of them occur on the coasts of Guiana, where *H. thelxiope* has never been found." The only deduction, which the author himself draws from these facts is, that *H. thelxiope* is a good and true species, which has been deduced by *natural selection* from *H. melpomene*. We hail with pleasure both facts and conclusions, and make no doubt that our readers will find in the pages of this work, ample evidence in support of the Darwinian theory.

The second volume is devoted to the narration of adventures in the Upper Amazons, Santarem, and Ega. Leprosy appears to be very prevalent in the former, but from the symptoms as described by Mr. Bates, we are led to suppose it is of a nature different from the usual varieties of this disease. The conventional supposition that every human race, no matter how aboriginal, exhibits some conception of a Supreme Being, is not borne out by the author's experience. "None of the Indian tribes on the Upper Amazons have an idea of a supreme being, and consequently have no word to express it in their own languages." The chapter on the forms and distribution of monkeys is pregnant with interest, and contains what may be considered the grandest speculations of this zoologist.

While passing over the pages of Mr. Bates's book, we became almost insensible to surrounding objects, and well-nigh fancied we were wandering through the mighty forests of Brazil, surrounded by the humming insects and gaudy-plumaged birds, whose natural history the author has so vividly portrayed. It has never been our lot to divide the pages of a more interesting or instructive work, and we heartily recommend it to all our readers.

FISH HATCHING.*

THE production of fish by the artificial incubation of the ova which have been collected on the spawning beds or extracted from the female, has engaged much attention of late years. It is, too, a subject worthy of all the consideration it is likely to receive, and which may, we trust, be taken up by all classes of the community. Very large sums of money are, from year to year, expended on the cultivation of domestic animals, which, when reared, still demand a considerable outlay, in the shape of food, care, &c.; whilst little or no trouble has been taken to rear animals which, in a pecuniary point of view, are just as valuable, and which possess the additional recommendation, that they do not require to be fed. It is quite true that, once we have hatched our fish-eggs, and sent their produce into our rivers, they are no longer our own property; but then, as Mr. Buckland very correctly observes, the country is benefited, and materially benefited, whilst our philanthropy has not cost us a penny. Who would not be a philanthropist under such conditions, especially when

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* "Fish Hatching." By FRANK T. BUCKLAND, M.A., F.Z.S. London: Tinsley, Brothers. 1863.

the occupation is so amusing and instructive? The volume now under notice is in great measure a report of a lecture delivered at the Royal Institution on the 17th of April last, and, like the original, is couched in the language and is full to overflowing with the *sotto voce* comments, which produced such bursts of laughter in Albemarle Street. No one who has read this little volume can be dissatisfied with the information it contains. It is calculated to make many converts, and in a practical and utilitarian point of view will doubtless effect good service. It is a book above all others to be worshipped by the disciples of Izaak Walton. With this admission, we proceed to investigate its character as a scientific work, and we regret to have to take the author to task on one or two points where he has stepped beyond his own province. He points out to his readers that in the young fish the lower jaw is but feebly developed, because it is not required for some time; the little creature being nourished by the supply of yolk in the umbilical bag. He is not, however, content with this explanation, but proceeds to draw a most blundering conclusion respecting the development of the human jaw. He says, "In the *human* baby the first portion of the body developed is the *lower jaw*, because the most material want of the baby is to obtain the mother's milk by suction. Now, if the lower jaw were not solid and firm, in vain would it try to suck." What, in the name of all laws of development does Mr. Buckland mean? Can he be ignorant of the beautiful researches of Reichert and others, showing that the jaw is formed at a much later period than other structures, and that it results from a modification of one of the visceral arches? No: far be it from us to suppose so. He means that it is one of the first cartilages in which lime-matter is deposited. But what has that to do with suction? Surely the *suctorial* muscles are not so much connected with the *lower* jaw as he implies; and, furthermore, the cartilages would, even in their un-calcareous form, sufficiently resist the muscular contractions. We think also that the author's teratology is slightly at fault. When, however, Mr. Buckland confines himself to fish-hatching his statements are most valuable. The appendix, containing descriptions of the experiments conducted, to determine how long ova preserve their vitality when buried in ice, and the report by M. Coumes on the fisheries of France, deserve perusal. A list is given of the works already published on the subject, thus rendering this volume a useful handbook to all those who are not disposed to accept Dr. Johnson's definition of an angler.

ZOOLOGY FOR SCHOOLS.*

WE say it advisedly, few men have done more to encourage the study of Zoology than Mr. Robert Patterson of Belfast. A distinguished naturalist himself, and one of whom Ireland may well feel proud, he was the first who really gave an impetus to the study of Natural

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* "Introduction to Zoology for the Use of Schools." By Robert Patterson, F.R.S. Belfast: Sims & M'Intyre. New edition. 1863.
"First Steps to Zoology." By the same author. Third edition. 1861.

History in that country. In the year 1846 his first edition of the above work appeared, and met with the success it merited so well. Since that time, however, considerable revolutions have taken place in comparative anatomy and systematic zoology; of the classifications adopted in 1846 there are very few extant now, most of them have been seriously modified, some of them have been entirely rejected. Creatures which then had been looked on as fish are now ranked among reptilia. Certain reptiles of that date are amphibia now-a-days. In fine, it became necessary for Mr. Patterson to subject his book to a complete revision, and to make several alterations and corrections. This he has now done, adding new matter to the text, and adorning the pages with numerous additional illustrations.

The invertebrates are divided into four sub-kingdoms, Protozoa, Radiata, Annulosa, and Mollusca. We congratulate the author on the introduction of the first and third, and the abolition of Articulata as a type; but we do not care to see the old term Radiata preserved, especially as it still includes the Echinodermata. We would not elevate the latter to the dignity of a sub-kingdom, as Professor Thompson does, but they might be placed alongside some of the classes of the Annuloida section of Annulosa. The author very properly employs the term Cœlenterata to include the Actinozoa and Hydrozoa; and since in a note he suggests the propriety of constituting the group thus formed into a distinct sub-kingdom, we can hardly object to his preference for the old designation, especially as the work is intended for schools, and the greater the introduction of new systems the greater will be the confusion necessarily created in the class-room. A great deal of valuable and new matter has been added to the chapter on Protozoa, and the division of this group into Rhizopoda, Spongiadæ, Infusoria, and Gregarinidæ, is one which even the most critical must approve of. The removal, too, of Rotifera was a step in the right direction. In dealing with the Medusæ the author introduces a few of Edward Forbes's beautiful sketches of the gymnopthalmata, and gives notes containing copious references to the works of zoologists who have made original researches upon the subject. It is a peculiar feature in this chapter, that the term *polypite* has been substituted for the less exact expression *polyp*, and that the Cydippe and Beröe have been classed with their relatives the sea-anemones. The class Echinodermata is subdivided as in former editions, the Siponculidæ being, however, grouped with the Annuloida. In the arrangement of Mollusca and Annulosa we observe the same indications of advancement as those seen in that of Protozoa and Cœlenterata. That portion of the book devoted to Vertebrates has undergone less alteration than the preceding parts. Cuvier's classification of fish is adopted, but that of Müller is given in a foot-note, together with much valuable information on the bibliography of the group. The mammals, birds, and reptiles are systematized in the usual manner. We are glad to perceive that the Dodo has been placed among the Columbida, but we conceive that the true affinities of Lepidosiren are not with fishes. In conclusion, without desiring to draw invidious comparisons, it may be said of this treatise that in point of scientific accuracy and clearness of description it is one of the best that has yet been presented to the public.

OPHTHALMOSCOPIC SURGERY.*

THE thanks of all members of the medical profession are due to Mr. Hogg for the production of a new edition of a work, which he has modestly termed a "Manual of Ophthalmoscopic Surgery." It may be truly said of the ophthalmoscope, that it is as valuable an agent in the detection of ocular disease as the stethoscope is in the diagnoses of pulmonary affections. There is no calamity which can befall a human being more disastrous than the loss of that sense by which we become cognizant of the existence of surrounding objects. And as we know that the little instrument which has given its name to the new branch of surgical science, is, in skilled hands, the most efficient means of discovering the early stages of diseases of the eye, it behoves us as practitioners to whom a serious responsibility attaches, to do all that we possibly can to promote "a proper knowledge of the use and advantages of" the ophthalmoscope. It need be no longer the excuse of local surgeons, that no book exists which is at the same time scientific, practical, and easily understood, for, in the volume lying on our table, we have these three qualities combined, in a manner which it is not often our good fortune to observe. The history of the discovery of the opthalmoscope is dealt with in a very impartial spirit, and it is with extreme satisfaction we perceive that the claims of our countryman Mr. Cumming are fairly exposed. We read, "It may be gathered from these remarks, that the first practical suggestions for the present mode of examining the internal eye and investigating its diseases, were made by Cumming. In the objects stated with which he commenced his experiments, in the means he used when examining eyes, and the precautions necessary to obtain the desired effect, we find all the fundamental principles engaged in the practice, or which enter into the theory, of the ophthalmoscope." Some eight or ten pages are given to explanations of the construction and varieties of the new instrument, the forms known, Liebreich's, Anagnostaki's, Grandmont's, Meyerstein's, and Nachet's binocular, being carefully described and commented on: in alluding to the last, the author expresses his opinion that experienced observers will "continue to prefer the much more portable form so generally employed, all the deficiencies of which may be corrected by a little patience and tact." As we should have expected, the optical principles involved in the instrument are treated of in the fullest and most exact fashion. The chapter on the histology of the organs of vision is not behind the time; and the views of Virchow, Schlemm, His, Donders, Strube, and Kölliker are discussed at length. In the physiological section we have been provided with lucid abstracts of the

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* "A Manual of Ophthalmoscopic Surgery." Being a practical Treatise on the Use of the Ophthalmoscope in Diseases of the Eye. By JABEZ HOGG, Senior Assistant Surgeon to the Royal Westminster Ophthalmic Hospital, Fellow of the Linnean Society, &c. London: John Churchill. 1863. 3rd Edition, entirely re-written and enlarged.

doctrines of the distinguished ophthalmologists Cramer, Helmholtz, Gräfe, Pilz, and Mannhardt; and it is not without a feeling of pleasure that we find the author opposing the opinions of the two first regarding the supposed change of form in the lens. In speaking of the power of adjustment Mr. Hogg goes on to say,—"For my own part, I believe that in the accommodation of the eye, the curvature of the crystalline body is unchanged." We cannot however agree with the concluding portion of the sentence,—"that *its* movements depend upon the special organisms provided for this important purpose." The experiments of Budge and Waller are detailed, and a *resumé* of the curious speculation of Professor Draper is also given. The purely surgical matter must recommend itself to the practitioner, containing as it does the results of Mr. Hogg's vast experience, and including the reports of several of the author's own cases. The arrangement of the classes of disease may be objected to by pathologists, but will undoubtedly be approved of by the practical surgeon. Four beautifully coloured plates, representing the appearance of the eye in the healthy and morbid conditions, accompany the volume, to which is appended a useful series of Jäger's "test types," so often alluded to by ophthalmic surgeons. Mr. Hogg was, we believe, the first in these countries who gave a detailed account of the new instrument, and we trust his work may meet with all the success it merits.

THE ANGLER-NATURALIST.*

IT is indeed desirable that fishermen should become better acquainted with the scientific bearings of their finny capture than they seem to be at present, and therefore from this point of view the author's undertaking is commendable. But before commencing the arduous task of writing for the instruction of the public, it would be as well that compilers put to themselves these two questions: first, Is there any work in print which is likely to fulfil the desired end? and second, From what sources may the information be obtained which it is necessary to convey? If these queries were seriously considered and conscientiously answered ere an author wields his pen, we conceive that publishers would be saved from much unprofitable outlay, and readers spared a considerable amount of trouble. The "Angler-Naturalist" has been written to supply a supposed want—the scientific instruction of anglers,—and, as it were, that it should be the constant companion of the fisherman, it is provided with a very pretty folding cover, to prevent any injury it might be likely to sustain while lying within the pocket of its proprietor. Even here we must enter our protest against the habit of making *pocket* volumes of such an enormous size. Why, even in a fishing-basket Mr. Pennel's work would occupy a

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* "The Angler-Naturalist." A popular History of British Fresh-water Fish, with a plain Explanation of the Rudiments of Ichthyology. By H. Cholmondeley Pennel. London: Van Voorst. 1863.

very considerable space; and we certainly are not ourselves possessed of any cavity within our garments, sufficiently capacious to contain his treatise. The illustrations, which are exceedingly numerous, will be admired by every one who reads the volume; but since they are almost unexceptionally those which long since appeared in the works of another author, we can hardly award much praise to Mr. Pennel on that score. As regards the typography and general finish of the volume, we need only say that it has been sent out in that garb which characterizes all Mr. Van Voorst's books.

The text is divided into two portions, the earlier pages being confined to an outline of the principles of ichthyology, whilst the remainder of the volume is devoted to descriptions of the habits and zoological characters of our native fresh-water fish. We do not think that the author has been very felicitous in his endeavours to give a popular delineation of the organization of fishes, as even in the outset we detect a very decided error in his definition of the class. In defining the group he says, "Fishes are oviparous vertebrata *with a double circulation*, and respiring through the medium of water." It is hard to believe that Mr. Pennel comprehended the meaning of his own definition; for a double circulation is one of the characters which fishes *have not*, and which reptiles, birds, and mammals possess in common. Again, the author is decidedly wrong when he asserts that fishes respire atmospheric air by the gills. The habit which fish, in impure water, exhibit of coming to the surface and taking in air by the mouth has been often explained. It has been found that the air thus taken in is swallowed, and instead of passing through the gills is transmitted to the stomach. In the taxological portion of the work we are treated to the natural history of British fresh-water fish, and this is certainly the more correct and interesting division of Mr. Pennel's book. For although the materials are drawn to a great extent from the excellent standard "History" of the late Mr. Yarrel, yet there are many new facts introduced, and the descriptions abound in anecdotes of an amusing and instructive character. The chapter on the salmon family, if we exclude the allusion to the *insect* nature of the Lernea, and that on the Cyprinidæ or carps, will prove acceptable to the general reader.

THE ESCULENT FUNGUSES OF ENGLAND.*

IT cannot be denied that there is a strong prejudice in this country against everything in the shape of fungi; and when it is considered that our shipping, our potatoes, and even our wheat crops often fall victims to these lowly organized growths, the prejudice appears to have a

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* "A Treatise on the Esculent Funguses of England." Containing an Account of their Classical History, Uses, Characters, Development, Structure, Nutritious Properties, Modes of Cooking and Preserving, &c. By Charles D. Badham, M.D. Edited by F. Currey, M.A., F.R.S. London: Lovell Reeve. 1863. New Edition.

tolerably fair foundation. To remove the very widely-spread, but incorrect, ideas prevalent in the minds of the people on this subject, by the dissemination of well-ascertained facts, tending to prove that many species of mushrooms are edible, is the task to which Dr. Badham addressed himself some years since. What success his efforts met with remains to be shown. It is, however, to be presumed that the results were satisfactory, else we should hardly have been presented with a new edition, which differs in scarcely any particular from the first one. Such as it is, however, it will, no doubt, be read by those interested in the cultivation of fung*uses*, and therefore we proceed to analyze it briefly. The chapters devoted to the general history, qualities, &c., of the group are instructive, but are evidently the produce rather of "scissors and paste" operations than of any originality upon the part of the author; and as the statements made are frequently given on very equivocal authority, we are forced to accept them *cum grano salis*. One is gratified to learn that the value—even on an estimate considerably below the mark—of Roman fungi is £4,000 per annum; but when this fact is adduced as an argument in support of the home-growth of fungi, we feel compelled to remark that there are a few trifling differences between the climatal conditions of Great Britain and Italy. The etymologies of the various generic and specific titles are well exposed, and the origin of the word Toad-stool is nicely explained as being derived from the German *tod*, which signifies death. That fungi are very universally-spread organisms is demonstrated in numerous examples, and among others allusion is made to the *Geastrum* which Withering found upon the topmost pinnacle of St. Paul's. Fantastic are the forms assumed by these curious members of the vegetable kingdom. "Some shoot out into branches like seaweed; some puff themselves into puff-balls; some thrust their heads into mitres; these assume the shape of a cup; and those of a wine-funnel. . . . . these are stilted on a high leg; and those have not a leg to stand on; some are shell-shaped; many bell-shaped; and some hang upon their stalks like a lawyer's wig." Descriptions of the odours and tastes, expansive power, motion, dimensions, uses, and modes of distinguishing between poisonous and deleterious specimens are not wanting. The origin of the so-called "Fairy-rings" is indirectly attributed to one of three causes, which certainly seem adequate to their production; and before entering upon the classification of these plants, an outlinear view of their development is added. This sketch is not particularly remarkable for its accuracy, and were it not for the note appended to the book, we should have commented more at length upon it. The rest of the volume is occupied with descriptions of the species, and of the method of preparing them as articles of diet; but owing to the absence of any simple scheme by which—after the manner adopted in a flora—a species may be easily named, the book cannot be safely employed (with a view to the edibility of fungi) by an unskilled person. The twelve beautifully-coloured plates may offer some assistance toward identification, but plates even of the best description are often very deceitful.

BRITISH LAND AND FRESH-WATER MOLLUSKS.*

MUCH more has been done on the other side of the Channel toward clearing up the history of the above-named animals than has been accomplished in the British Isles. For even though the characteristically-speculative labours of Edward Forbes threw a good deal of light upon the distribution of these beings, still English conchologists were far behind their Gallic neighbours in this respect; and we have had no work in our language which could in any way be compared with the diffuse and able researches of M. Moquin-Tandon as published in his "Mollusques Terrestres et Fluviatiles." The gap which so long existed has now been filled, and in filling it Mr. Lovell Reeve has brought the whole weight of his extensive conchological researches to bear upon the subject. Need we say, that he has produced a volume which is creditable to him in his double capacity of naturalist and publisher? We think not. *One hundred and twenty-eight species* have been described, and in every instance the descriptions are so ample and lucid that the merest tyro in molluscan zoology can find the identification of a specimen a matter of very little difficulty indeed. An exquisitely-finished engraving of the typical *animal* of each genus is intercalated with the text, and smaller woodcuts of the shells or animals accompany the several descriptions of the species. The lists of synonyms are copious and carefully prepared, and the habits of each species have been by no means neglected. The portion of the work, however, to which we would direct especial attention is that which refers to the distribution of specific forms; this is incontestably the most valuable in a philosophic point of view, and it is to it that those endeavouring to solve the great problem of the origin of species will look for information. No pains have been spared by the author to render this branch of his subject as explicit as possible, and throughout the pages will be found admirably-drawn-out schemes explanatory of the geographical ranges of the various species. Taking *Helix nemoralis* as an illustration of how Mr. Reeve has advanced our knowledge of terrestrial mollusks, it will be observed that a scientifically-accurate description of the shell is first given, then that a list of fifteen synonyms, with dates, the habitat, and more than half a page of general description follow, and finally that the distribution is thus described:—"*H. nemoralis* inhabits Europe throughout, but it is less common in the South. It has been transported to the United States, and keeps to the eastern parts near the sea, especially the lower extremity of Cape Codd and Cape Ann. Mr. Binney remarks, that in the neighbouring islands 'each island is inhabited by a variety peculiar to itself, showing that the variety which happened to be introduced there has propagated itself without a tendency to run into other variations.' Thus, on one island

* "The Land and Fresh-Water Mollusks indigenous to, or naturalized in, the British Isles." By LOVELL REEVE, F.L.S. London: Reeve & Co. 1863.

we have a yellowish green, unicoloured variety, once described as *H. subglobosa*, and on another, within a very short distance, we find a banded variety and none others." We have not selected this quotation specially, and therefore we regard it as a good proof of the value of the entire work. We are not disposed to accept the opinions expressed in the last few pages, but think them exceedingly original and ingenious, and calculated rather to assist than retard the view of Mr. Darwin. The Analytical Key, which resembles that of Mr. Bentham's Flora, is novel, and likely to be of service in the estimation of species. A good general idea of distribution may be derived from the study of the map. There is an appendix of eight pages, furnishing the titles of all the works referred to by the author; and the frontispiece exhibits a well-executed steel engraving of the celebrated Draparnaud, a circumstance which lends an interest to a volume that will be purchased by every working zoologist in England.

NATURAL HISTORY AND SPORT IN MORAY.*

HERE is a book to please all lovers of sport. It consists in the arranged notes and journals of that celebrated naturalist-sportsman, the late Mr. Charles St. John. All Highland sportsmen and most English ones must be familiar with his name. He was one of those men who, though enthusiastically fond of animals as associated with *sport*, was nevertheless an acute observer of nature, and one whose greatest pleasure was in watching the haunts and the habits of animals, and in narrating to his friends the results of his pursuits. Mr. Innes, the collector and editor of the materials which now constitute a most interesting work, has discharged his office well, and the arrangement pursued by him will doubtless meet with approbation on all sides. The author's observations, which of course extended over many years, have here been grouped in accordance with the months in which they were made, so that we have a record of animals, &c., seen, shot, and preserved in each month of the year. Let us see what we have in the first chapter, under the heading of January. First, the *wood-pigeons* are alluded to, and their inability to pierce the hard skin of the turnip with their beaks is briefly touched on; then follows a description of the titmice, those pert, prying little birds which come hopping about our gardens in this inclement season; and our author, writing in his pleasing, colloquial style, remarks of one of these (the little blue tomtit): "Like the greater titmouse, the little bird is quite omnivorous, feeding on everything that comes in its way. It is fond of carrion, and I have frequently seen it feeding on dead mice or rats. It comes boldly to the window, and even into the room, in search of flies. It is, however, very impatient of confinement, and difficult

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* "Natural History and Sport in Moray." Collected from the Journals and Letters of the late Charles St. John, Author of "Wild Sports of the Highlands." Edinburgh: Edmonston & Douglas. 1863.

to keep alive in a cage. . . . . It is a busy, meddling little bird, at the head of all attacks on cat or owl that may stray into the gardens or shrubberies, seeming to become quite infuriated against these enemies." Next, the auk and widgeon receive the author's attention, and the red shank, oyster-catcher, water-rail, field-fare, whimbrel, and purple sandpiper come in for their share of his remarks; he has always a few words for each of them; and as he speaks, in every instance, from personal experience, his statements are worthy of consideration. Relating his observations during the month of April, he writes: "Riding by the heronry on the Find-horn, I saw the Altyre keeper searching in all the jackdaws' nests that he could reach for the remains of the herons' eggs. These active little marauders live in great numbers in the rocks immediately opposite the herons, and keep up a constant warfare with them during the breeding season, stealing an immense number of their eggs, which they carry over to the holes and crevices of the opposite rocks, and eat them, out of reach of the herons." All through this volume may be found passages of a similarly interesting character to those just quoted, and in all we may trace the ardent love of nature for which the author was remarkable. Very little attention has been paid to invertebrates, "birds, beasts, and fishes" appearing to have been his favourites. Almost every British bird has been noticed to some extent, and numbers of mammals and fish have been recorded and described. The book has rather the features of a diary than of a continuous narrative; and, although for that reason it may be distasteful to some, we consider it to possess more value as a work for the perusal of those who are desirous of studying not only the habits of animals but also the periods of their appearance. It is a volume which should be in the library of every country gentleman.

THE REASON WHY: PHYSICAL GEOGRAPHY AND GEOLOGY.*

WE regard accurate compilations as among the most useful of all forms of publication. The student who is endeavouring to inform himself of the exact existing condition of any particular branch of science, cannot—unless indeed his leisure be more ample than that of students generally—afford the time which it is necessary to expend in poring over ponderous tomes and myriads of serials, to obtain what a well-compiled hand-book would present to him in a few hundred pages. Hence

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* "The Reason Why: Physical Geography and Geology." Containing upwards of Eleven Hundred Reasons explanatory of the Physical Phenomena of the Earth, its Geological History, and the Geographical Distributions of Plants, Animals, and the Human Families. By the Author of the "Reason Why: General Science," &c. London: Houlston & Wright. 1863.

we find, that in most instances manuals, text-books, hand-books, "*et hoc genus omne*," are preferred, as offering a simpler path to learning than that we have alluded to. "The Reason Why" is, in our opinion, a work by no means inferior to any of its class. It embraces two kindred branches of knowledge: Physical Geography and Geology; and since these are linked together by Zoology, the latter has found a place in this volume. The system pursued in the treatment of the subject is the catechetical; and although for the purposes of continued reading this is somewhat objectionable, it is nevertheless a very useful method in the hands of a teacher. The Geology is especially good, and the wood-cuts, taken, as they have been, from the works of recognized authorities, form valuable adjuncts to the text. The notes in smaller type show that the compiler has given his subjects more than superficial examination, and serve to render the work a really compendious book of reference for the general reader.

SYNOPTICAL TABLE OF AQUEOUS ROCK-GROUPS.*

THE author of the monograph on the Permian fishes has drawn up the tabular classification which lies before us. It is, we believe, intended for the use of students, to whom it offers many advantages not usually possessed by schematic tables of its class. The plan is divided into five columns: in the first is placed the name of a class (primary, for instance), the second embraces the various systems this class includes (Cambrian, Silurian, Permian, &c.), in third and fourth are ranked the different formations, one being set apart for marine, and the other for land and fresh-water types, whilst in the fifth stand the organisms characteristic of the entire system. We notice the introduction of two new terms employed to designate the pleistocene and post-pleistocene systems, which Professor King styles the "Clydian" and "Argyllian" systems respectively.

WILD FLOWERS AND THEIR USES.†

THE authoress expresses a perfectly just opinion when she says, "The task of writing for children is by no means so easy as many people imagine." In this *brochure*, however, an attempt—and we think a tolerably effective attempt—has been made to construct a series of stories which, though of a character adapted to the comprehension of children, have, as it were, interwoven with them much genuine botanical instruction. The illus-

* "Synoptical Table of Aqueous Rock-Groups." By WILLIAM KING, Professor of Geology in Queen's College, Galway.

† "Wild Flowers and their Uses." A Book for Children. By CAROLINE SOUTHWOOD HILL. Edinburgh: W. & R. Chambers. 1863.

trations representing the commoner plants met with in an ordinary ramble are correctly executed, and the selection is judicious. If parents be desirous of imparting to even young children a little of the science of plants, this is decidedly the book to invest in.

THE MANAGEMENT OF STEEL.*

IF practical experience, conveyed in plain language, be a recommendation, then will Mr. Ede's little book be read by all whom mechanical and metallurgical information may concern. His remarks on the methods of hardening steel are exceedingly reasonable, and are likely to work a reform in the ordinarily-adopted processes. While on the subject of "tempering," he throws out some important hints relative to the boiling of oil employed in the operation. The directions given in regard to the expansion, case-hardening, shrinking, and annealing of steel are suggestive, and are worthy the attention of the mechanical engineer.

HOME WALKS AND HOLIDAY RAMBLES.†

THE little book which bears this title bids fair to become a popular favourite, not only with that class of the community which scours the country in search of bird and moth, but also with those who are to be found upon the sea-coasts, engaged in the collection of "common objects." It is written in a very attractive manner, and illustrated by several original sketches, which, as they delineate scenes that have occurred in the author's excursions, lend another interest to the volume. All our familiar animals and some of our native plants are commented on, the allusions proving that Mr. Johns is an experienced observer of nature, and one capable of imparting information successfully. His book is just the one likely to cultivate a taste for natural science, and we hope it may have an extensive sale.

* "The Management of Steel." By GEORGE EDE. Second edition. London: Tweedie. 1863.

† "Home Walks and Holiday Rambles." By the Rev. C. A. JOHNS, B.A., F.L.S. London: Longman. 1863.

Plate

J.Buckingham, C.E. del.

May 7 1863

JUPITER, 1863.

NATURAL HISTORY.

SCIENTIFIC SUMMARY.

ASTRONOMY.

During the summer quarter the opportunities for planet and comet discoveries are rather limited on account of the shortness of the nights, so that there is but little to record for the last three months. A new variable star has been detected at the Madras Observatory by Mr. Pogson, which is, we believe, the only astronomical novelty of the season.

Winnecke's Comet.—The comet of short period known as Winnecke's comes into sight in the winter of 1863, arriving at its shortest distance from the sun on November 23. It will not be well seen in those latitudes on this occasion. It sets about an hour after the sun during the month of November, and from one to two hours in that of December; and being in the same parallel, it will of course be faint from the strong twilight in that quarter. In the months of January and February it will be a little more favourably situated, but its distance from the sun and earth will have increased considerably. It is situated in the constellation of Libra at the beginning of November, and passes to Capricornus at the end of the year. On Nov. 2, its R.A. is $15^h\ 9^m$; Nov. 18, $16^h\ 34^m$; Nov. 30, $17^h\ 45^m$; Dec. 12, $18^h\ 59^m$; and Dec. 28, $20^h\ 33^m$. Its south declinations at those times respectively are 13° 23′, 19° 44′, 23° 4′, 24° 24′, and 22° 53′. This will serve to indicate its path to those who may turn their telescopes in that direction. It is at its shortest distance from the earth on Dec. 8, when it will be more than 150 millions of miles distant. Its shortest distance from the sun is 73 millions of miles.

Distance of Sun from the Earth.—Professor Hansen has deduced from his lunar tables a value of the solar parallax, closely agreeing with that given by the late opposition of Mars as discussed by Mr. Stone. Mr. Hind has drawn up a long and valuable account of the later history of this important question, which it is to be hoped will be set at rest in less than twenty years' time—it cannot be done sooner in all probability. The increase of the solar parallax from 8″·5776 to 8″·95 depends on six entirely distinct authorities, but astronomers will probably retain the old value until the next transit of Venus. It may be remarked, *en passant*, that the value found from the passage of Venus in 1769, taking the observations made at Otaheite, California, Hudson's Bay, and combining them with those of Paris and Petersburg, gives a parallax of 8″·9142, very nearly the same as that lately suspected. The extreme results given by the observations on that occasion are very different, being 8″·15 and 9″·25. Doubtless on the next occasion those great discrepancies will not occur, as we may fairly expect more experienced observers and

better instruments; but as much depends on the steadiness of the sun and absence of tremor in the atmosphere, they can scarcely be entirely avoided. Even at the same place of observation, as at Paris, Greenwich, London, and Oxford, the difference of the times of contact of the margins of Venus and the sun, as given by different observers at those places, varied between sixteen and twenty-five seconds. By the proposed increase in the solar parallax, the earth is brought closer to the sun by four millions of miles, and the annual path of the earth is diminished by some twenty-five millions of miles, so that it does not travel at such a rapid rate as was formerly supposed. The distances and dimensions of all the planets are similarly decreased (as expressed in miles), that of the moon, however, remaining as before. These are matters of simple curiosity, but even a slight change in the actual parallax of the sun will produce but little effect in the most delicate investigations of practical astronomy. From the combination of the Williamstown and Greenwich observations of Mars, as made by Mr. Stone, the extreme values of the parallax are 9″·65 and 8″·50, the mean result of all being 8″·932, and the probable error 0″·032.

Occultation of Kappa Cancri.—In the last summary the phenomenon of an interruption in the light of this star at the moment of immersion was mentioned as witnessed by Mr. Copeland. The occultation was fortunately seen by several observers. Captain Noble writes that he observed it with an excellent telescope by Ross, of 4¼-inch aperture, but did not perceive any diminution of its light. Mr. Vertu, who saw it at Nottingham, says that he followed it until in contact with the moon's edge, when it disappeared *instantaneously*. This observer states, that although the moon was nine days old on this occasion, the complete circle of its disc could be traced, and even some features in the dark part were discernible, and thinks that the impression of the diminution of light was due "to the excitement produced on the retina by an intense and protracted gaze at the object."

Klinkerfues's Comet.—This, the second comet of 1863, is still visible, but from its great distance from the earth is exceedingly faint. Its position on Oct. 1 is R.A. $12^h\ 7^m$, declination 57° 35′ north. It has then only one quarter of the brightness which it possessed on July 15, when it was waning in lustre.

Mars.—Mr. Lockyer took advantage of the favourable position of Mars at its last approach to the sun and earth to make a complete examination of its surface, and to compare it with the map made by Beer and Maedler in 1830, on which occasion it was nearly under the same conditions. It is satisfactory to learn that, with the exception of a few slight and fleeting changes, which he considers as due to the transit of clouds over the planet, all the features noticed by the earlier observers were reproduced in the most marvellous manner; and although Mr. Lockyer had the more powerful telescope, yet it only served to show the old details more plainly. The changes noticed were principally in the tones of the different parts of the planet, both light and dark, which he says occur daily, if not hourly.

Companions of Sirius.—The minute points of light detected by the

patience and perseverance of M. Goldschmidt around this star (and which he states have undesignedly been termed satellites) are considered by this eminent observer to be real objects. In order to guard against optical illusion or "sickness of the eyes," he turned his attention to other bright stars, such as *Altair* and *Antares*, but could perceive nothing similar to the appearances observed in Sirius. The object rediscovered by Mr. Dawes, and which is about four seconds (in time) to the east of the star, although the most conspicuous from its distance, is not considered by M. Goldschmidt to be so bright as the two nearest ones, which he says "seem to be bodies of great importance relative to Sirius." All those discoveries have been made with an object-glass of only four inches in aperture!

Observations by Reflection compared with Direct.—It is well known that zenith distances taken with a meridian circle in the usual manner, differ in a sort of regular discordance with those observed by reflection in a trough of mercury. By some it has been attributed to flexure of the telescope when approaching to a horizontal position, in which it is generally greatest. Professor Airy, however, endorses the opinion of M. Faye, that it is caused by the condition of the atmosphere and its warmer and cooler strata in the observing-room. The latitude of an observatory, the Astronomer-Royal states, may be wrong to the extent of a quarter of a second, if direct observations only are used, and that polar distances of seventy or eighty degrees are uncertain to half a second. The only method of removing this source of error, he maintains, is by making use of reflection observations on both sides of the zenith.

Clock-driving Apparatus for Telescopes.—The utility of a uniform motion for equatoreals, by which the star is kept in the same field of view of the telescope, is beyond doubt; and when micrometrical measures are wanted it can scarcely be dispensed with. M. Foucault has been for some time occupied with this problem, and has just completed a machine for the purpose, which is about to be applied to the great equatoreal of the Paris Observatory. Lieutenant-Colonel Strange speaks highly of its time-keeping qualities, and M. Foucault affirms that for all practical purposes uniformity of rotation under considerable changes of resistance is absolutely obtained by it. The invention has been patented in France and England.

Shooting Stars.—During the present autumn the fall of meteors has been very remarkable, both in respect to their number and brightness. The majority occurred on August 10.

Eclipses of the Sun and Moon.—At the last meeting of the Astronomical Society various observations of the late eclipses were presented. Captain Noble states, in reference to that of the moon on June 1, that he never remembers to have seen such a nebulous density in any other lunar eclipse as that presented by the shadow on this occasion. In the eclipse of the sun, Lord Wrottesley states that the cusps and limb of the moon were sharply defined shortly after the commencement, but that afterwards the limb became tremulous, and viewed with the large telescope appeared much jagged, resembling the teeth of a saw.

Solar Faculæ.—A very conspicuous bright streak was noticed on the

edge of the sun close to a spot, by Captain Noble, on May 24. It gave the idea of a most extraordinary elevation above the general surface of the sun, and presented a perfect stereoscopic effect. So strong was the shading on one side of this great ridge of light that it appeared at one time probable that it was a spot greatly foreshortened. This was, however, afterwards found not to be the case, as the facula was quite isolated. This is a further proof that the faculæ are considerably elevated about the surface of the sun.

Lunar Discoveries.—Dr. Lee, the late venerable President of the Astronomical Society, gave an account, at the last meeting of the British Association, of the new mountains and seas discovered in the moon. He purposes to call them by the names of the house of Percy, and one after Professor Smyth, &c.

Dawes' Solar Eye-Piece.—At the same meeting Dr. Lee also gave a description of this instrument, which has now been in use for upwards of ten years. The peculiarity and simplicity of its construction consist in having a dark diaphragm, pierced with a minute aperture, before the eye-piece of the telescope. The whole aperture of the telescope may thus be used ; and Mr. Dawes has employed it not only on refractors of 8-inch aperture, but even on Lassell's 24-inch reflector, without having broken a single dark glass.

Jupiter.—The aspect of Jupiter is always interesting from the changes which are continually taking place on his surface, and have been more than usually so during the past apposition. By the kindness of Mr. Buckingham, F.R.A.S., we are enabled to give three representations of its appearance (*see* plate V.) during the spring of the present year. The intense blackness of the central spot, in comparison with the belts, was very conspicuous. On the evening of April 28, the upper belt was completely divided near the black spot, and a canal ran through it towards the east. A few detached spots on the central luminous belt were well seen. On the evening of May 7, the upper belt was speckled by a number of bright spots. A similar appearance was noticed by Mr. Lassel in 1850, who compared them to the disc of a satellite seen on the planet with a small telescope. Mr. Dawes has likewise been a witness to those luminous beads, and compares them to the smaller craters of the moon. Mr. Buckingham thinks that this intense black spot may be the same as that observed by Cassini in 1665, and which, according to that authority, was the same as seen by him at intervals up to 1713, thus remaining on the disc of the planet for nearly half a century. It would, however, be difficult to verify this conjecture. Those observations were taken by Mr. Buckingham with a telescope of $5\frac{1}{4}$-inch aperture, by Wray, and was one of those which, for excellent defining power, obtained the prize medal at the Great Exhibition of 1862.

Variable Stars.—A valuable and popular paper "on the method of making and reducing observations of variable stars," by Messrs. Knott and Baxendell, appears in the "Astronomical Register" of October, 1863, which will be found very useful to those desirous of undertaking such interesting observations.

BOTANY AND VEGETABLE PHYSIOLOGY.

The Existence of two Forms in several Species of Linum.—The beautiful discoveries of Mr. Darwin relative to the fertilization of Orchids and Primulæ have led him to inquire into the nature of this process in the flax tribe, and the results of his researches are quite as remarkable and interesting as any he has yet put forward. He finds that in the large flowered crimson flax two distinct forms of flower exist; in one the pistil being twice as long as the united styles and stigmas of the other. In that with the long pistil, the styles are erect, but in the other the five stigmas diverge and pass between the stamens to the base of the corolla tube. He has observed that the pollen of either form is unable to fertilize its own ovules, the stigma producing no action upon it; but when pollen from an opposite form is placed upon the stigma, the tubes are developed in a few hours. In *Linum perenne* the same two forms, long and short-styled, are present; but the stamens of the long-styled flowers are only half the length of those with the short styles; moreover, in the first variety, *the stigmas turn round so as to face the circumference of the flower about the time it expands.* What is the object of this divergence of stigmas in L. grandiflorum? The nectar secreted by the flower being found at the outer base of the stamens, the insect is obliged to insert its proboscis between the petals and stamens, and thus the foreign pollen is attached to the stigmatic surface. As in Linum perenne the stamens are of different lengths, so will pollen of different kinds be attached to the insect at two distinct levels, and will thus be brought in contact with the stigmas to which it is adapted. Mr. Darwin remarks:—"*In plants which are fertilized by the wind, the flowers do not secrete nectar; their pollen is too incoherent to be easily collected by insects; they have not the bright-coloured corollas to serve as guides, and they are not, so far as I have seen, visited by insects.*"—"Journal of the Linn. Soc."

Relation of Botany to Palæontology.—At the late meeting of the British Association in Newcastle-on-Tyne, Professor Balfour, President of the Natural History Section, made some interesting comments on the necessity of being thoroughly conversant with botanical science before attempting to draw conclusions as to the relations of fossil plants to each other and to the present vegetable kingdom. Numerous errors have been made by palæontologists, owing to an ignorance of botany. "Fronds of ferns, of different external forms, had been described as distinct fossil species, or even genera—the geologist not knowing that very different forms of frond were exhibited by the same species of fern in the present day. Again, another error had arisen from the same form of frond being considered as indicating the same species, whereas the same form did occur in different genera in the present flora, and these could only be distinguished by the fructification, which in fossil ferns was rarely seen." It was also shown that a conclusion might be drawn from the presence of palm-leaf, to the effect that at the period when it lived there must have been a tropical climate in its locality; but this conclusion was liable to be incorrect, from the circumstance that in the present day we find palms at high latitudes,

and in mountains, associated with cool growths of coniferæ. The professor terminated his address by observing that there was a mutual bearing of all the natural sciences on each other, and that the student of nature must take a comprehensive grasp of all.

Artificial Fertilization of Corn and consequent Increase of Crop.—Perhaps one of the most important discoveries, in a utilitarian aspect, that has been made for the last quarter of a century is that which has been just announced in France. The merit of the discovery is not, however, due to a Frenchman, but to a Dutchman, M. Hooibrenk; and the results of his researches have been so well marked and valuable that he has been awarded the Cross of the Legion of Honour by the Emperor, who has directed that a scientific commission be appointed to investigate and report upon the matter. M. Hooibrenk supposes that the number of grains in an ear of corn can be increased by bringing a larger* quantity of pollen into contact with the stigmas than they usually receive. He conducts his experiments as follows:—He takes a cord of from twenty-five to thirty yards long, and fastens to it a stiff woollen fringe of about ten inches long; he steeps it for a short time in honey, and then drags it over the fields of corn two or three times, after flowering. It catches the pollen from the anthers and applies it to the stigmata (it is, in fact, Mr. Darwin's bee-process on a gigantic scale), and the result is a greatly increased crop. This method has been tried in conjunction with the old one, on a farm near Epernay, in Champagne, the property of the celebrated wine dealers, Messrs. Jaquesson. The results beneath show the relative advantages of both systems:—

	Hooibrenk's System. Kilogrammes.	Old System. Kilogrammes.
Wheat	31	21
Rye	25·5	16
Barley	24	16
Oats	17	12

It has been conjectured that the results would have been still more striking had not this season been such a favourable one. Fruit and garden vegetables have been similarly treated, and with a like success. It has been found also that an inclination of 112° of the branches of the vine produces some effect upon the flow of the sap, and increases the fruit crop. M. Hooibrenk maintains that by his process, and without any material additional outlay, crops of fruit, vegetables, and corn can be increased in value 50 per cent.

Presence of Sap in the Vessels of Wood.—Notwithstanding the generally-received opinion that the sap is only to be found during certain seasons, in the woody tissue, M. Gris asserts that it is invariably present during the life of the plant, and that it is not mixed with air, as certain botanists imagine. In addition, he has in most instances detected sugar by the application of the sulphate of copper test, and he supposes this to arise from the serial conversion of starch into dextrine and glucose.

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* May it not also be due to the influence of the foreign pollen thus rought to bear on each plant?—Ed. P. S. R.

Diurnal and Nocturnal Expiration of Leaves.—The nature of the gases exhaled by plants during the day and night is still a question for botanists to solve. It has already engaged the attention of numerous physiologists and, among the number, of M. Corenwinder, who states as the results of his inquiries:—1st, That leaves generally give off carbonic acid during the night; but that the extent of this exhalation depends on the temperature—being reduced to nil when the thermometer approaches zero. 2ndly, In day-light, and especially if exposed to direct rays, the young shoots and buds give off carbonic acid—occasionally in considerable quantities,—thus showing that young leaves have not the power of absorbing and decomposing this gas. 3rdly, Adult leaves never expire carbonic acid when in the open air and receiving the light perfectly. 4thly, Coloured leaves do not differ from the ordinary green ones as regards the property of decomposing carbonic acid. M. Corenwinder experimented on specimens of hazel and copper beech, and found that they absorbed this gas in the daylight and exhaled it at night.

Do Diatoms live on the Sea-Bottom at Great Depths?—In answer to this query, a note appears from Dr. Wallich in the August number of the "Annals of Natural History." He believes that these plants do not exist at considerable depths of the ocean. "Although the soft parts are retained in specimens obtained from extreme depths, they differ materially both in aspect and qualities from those of diatoms known to be living." It is very remarkable that diatoms brought up from extreme depths never exhibit any movements; and as ordinary specimens possess a very decided power of locomotion, it seems fair to suppose that the former do not live at these depths. The *coscinodisci* which constitute the greater portion of the diatoms discovered in deep-sea deposits are essentially inhabitants of shallow water (from one to fifty fathoms), and they do not live in mud. According to Dr. Stimpson's researches, the diatoms were found distributed all through the mud, a fact which Dr. Wallich conceives to be highly indicative of the absence of vitality. Moreover, it is exceedingly questionable whether diatoms ever form the food of rhizopods.

The Leaf-Cells of Hymenophyllum have been subjected to microscopic examination by Professor Gulliver, and the results arrived at appear to support the view that *H. Tunbridgense* and *H. Wilsoni* are really distinct species. He states that in the former the leaf-cells are round, or nearly so, with an average diameter of $\frac{1}{571}$ of an inch, whilst in the latter they are oval, with an average long diameter of $\frac{1}{308}$ and a short one of $\frac{1}{615}$ of an inch. Especial stress is laid on the fact that in *H. Wilsoni* the cells are not only much larger but *distinctly* oval, and the terms *sphœrenchyma* and *ovenchyma* have been devised as diagnostics. Should the discovery prove to be correct it will be an additional aid to those botanists who delight in species, and will, we have do doubt, find its way soon into the ordinary floras.

Vegetable Muscular Tissue.—The anther tube of the cynareæ is supposed by Professor F. Cohn to have peculiar contractile powers not unlike those of the flesh-particles of animals. It is remarkable that, as the Professor states, the contractions are due to simple elasticity, while the alternating elongations of the tube are special muscular movements. This view is not unlike that proposed by M. Claude Bernard in regard to contractile

structures in the capillaries of man. If the thistle be watched at the period of flowering, it will be seen that the anther-tube is slightly elevated above the corolla, and that on being touched pollen masses make their escape, whilst the tube exhibits a curious twisting movement. However, this discovery is not more remarkable than that of the movements of the stamen-filaments in the *Berberidaceæ* and other orders of plants.

The Evolution of Buds.—A number of memoirs on this subject have been presented to the French Academy by M. Ch. Fermond; but the descriptions and generalizations are expressed in technical terms of so entirely novel a character that we must refer the reader to the originals for an idea of what the author intended to convey.—*Comptes Rendus*, July 20 and August 24.

The Artificial Development of Ascophora nigrans.—This plant, which is easily developed naturally in organic matter, has been produced by M. Raulin in artificial solutions. He finds also, that it affects certain salts rather than others, and gives the following as the results of his investigations:—The most suitable mineral substances are in order of importance—phosphorus, potassium, magnesium, sulphur, and manganese. A liquid holding all these substances in solution will, in a certain fixed time, develop 20 grammes of this plant; another, which differs from the first by the absence of manganese, produces only 5 grammes in the same period of time; the suppression of sulphur reduces the supply to 2 grammes, that of magnesium and potassium to 1 gramme, and that of phosphorus to 0·5 grammes. The quantities of these elements which must be employed form a very fractional part of the weight of the plant which is produced, less than two-hundredths in some cases. From several experiments which he has made, M. Raulin is enabled to conclude that free nitrogen is not absorbed by these plants.

Coloration of Vegetable Tissues by Acids.—The coloration which acids impart to the tissues of plants has received the attention of botanical chemists for some time past. Not the least distinguished of those who have given the subject consideration is M. A. Guillard, who now makes known the opinion he has formed. Acids, according to this investigator, exert an action not only upon portions of the *liber*, but they tinge completely the woody tubules and vessels, the medullary rays and even the central pith itself. Violet, with its various shades, is not the only colour exhibited on addition of a drop of hydrochloric acid; in some plants, as Staphylæa and Dianthus, a beautiful green is developed: in the *liber* of Sagina and Plumbago, and in the leaves and fibres of Myrica, a yellow is observed, whilst the Epacrideæ yield a splendid orange hue. This production of hues has been observed more frequently among dicotyledons than other groups, and the author considers it to be a fact of much importance in connection with the examination of the microscopic structure of vegetable tissues.

On the Germination of the Organic Corpuscles which are found in the Atmosphere.—M. Duclaux is engaged in a series of experiments on the germination of mould spores, and publishes the results he has already arrived at. He collects the spores on cotton by Pasteur's apparatus, and then steeps the cotton in a liquid containing sugar, some mineral matters,

and an acid salt of ammonia (bitartrate). A drop of the liquid containing the corpuscles is then placed under the microscope in a small vessel so constructed as to permit every part of it to be examined in succession. The origin and development of the vegetation of the germs may be then observed. So far, M. Duclaux's researches appear to confirm the conclusions formed by M. Pasteur from his admirable investigations into the nature of spontaneous generation.

New Colouring Matter (*Xylochloeric Acid*) *found in Decayed Wood.*—Decayed timber, presenting in the interior a peculiar green colour, sometimes very intense, is often found in forests. M. Fordos has succeeded in extracting from it a fine green colouring matter, apparently very stable and susceptible of important applications, if it could be easily procured. It is solid and amorphous, of a deep bluish green, with a coppery lustre. Insoluble in water, ether, sulphide of carbon, and benzine; insoluble or nearly so in alcohol; soluble in chloroform and crystallizable acetic acid. It does not appear to be altered by mineral acids, even when concentrated. It dissolves in sulphuric and nitric acids, giving green solutions, from which it is precipitated by water. Alkalies combine with it, giving it a yellowish-green tint.

Chlorine water, added in sufficient quantity to its solution in chloroform, transforms it into a yellow substance, which the chloroform retains in solution; and if ammonia be shaken up with it, after the chlorine reaction, a red compound, insoluble in water and chloroform, is produced.

Besides the green colouring matter mentioned, there exists in the wood, in very small quantity, a red colouring matter, easily changeable, and with the following characteristics:—It is insoluble in water, ether, sulphide of carbon, and benzine; soluble in chloroform and alcohol. It is by alcohol that it can be separated from the green matter.

In order to extract these colouring matters, the wood, cut into little chips, is treated repeatedly with chloroform until it is exhausted. The green solutions are shaken up with acidulated water to free the colouring matter from a little lime which accompanies it. The chloroform solution is then separated from the acid water and distilled, after adding some distilled water to it.

The chloroform distils over and the green colouring matter remains suspended in the water, from which it is freed by filtration, and then treated by alcohol to remove the red matter, which is present in very small quantity.

M. Fordos thinks that the origin of the green matter may be ascribed to a special transformation of the astringent substances contained in the wood at the time of its death, or rather of the matters carried into the dead wood by the juices of the living tree which had penetrated into it before it became detached.

The red matter offers some analogy with a substance widely diffused in the vegetable kingdom, called cyanine, paracarthamine, but differs from it in some particulars.

The green matter differs in chemical properties from chlorophyl, with which it might at first be thought identical.

CHEMISTRY.

Aniline Blue.—The conversion of red into aniline blue, discovered some years since by MM. Girard and De Lair, two young chemists from M. Pelouze's laboratory, occupies at the present time a very prominent position in the chemistry of dyes. Indeed, a very considerable manufacture, based upon this transition, is being carried on in England by Messrs. Simpson, Maull, and Nicholson, and in France by MM. Renard, Brothers, of Lyons. Till recently but little was known concerning the chemical changes involved in this conversion; but in a memoir lately communicated to the French Academy, the whole mystery has been philosophically unfolded by Dr. W. A. Hofmann (*Comptes Rendus*, 6th July). The author finds that the process for the transformation consists in treating rosaniline at a high temperature by aniline in excess. The change is readily achieved by treating salts of rosaniline in the presence of aniline, or reciprocally by treating rosaniline with salts of aniline, ammonia being in both cases given off. Several analyses of the hydrochlorate which had been supplied by Mr. Nicholson lead to the expression—

$$C_{38}H_{32}N_3Cl+$$

This formula contains the history of aniline blue; for not only does it point out its chemical character and the relation which it bears to rosaniline, but it most satisfactorily explains the change which takes place in the conversion of the red into aniline blue. The above formula may be fairly rendered as follows:—

$$C_{38}H_{32}N_3Cl=C_{20}H_{16}(C_6H_5)_3N_3HCl$$

In other words, the substance is the hydrochlorate of triphenylic rosaniline. This being granted, the equation beneath affords us a most exact explanation of the entire process, thus:—

$$\overbrace{C_{20}H_{19}N_3,HCl}^{\text{Salt of rosaniline.}}+\overbrace{3C_6H_7N}^{\text{Aniline.}}=\overbrace{C_{20}H_{16}(C_6H_5)_3N_3,HCl}^{\text{Salt of triphenylic rosaniline.}}+\overbrace{3H_3N}^{\text{Ammonia.}}$$

Dr. Hofmann has succeeded, moreover, in obtaining the free base, by pouring a concentrated solution of the chloride in ammoniacal alcohol into water; this substance is then separated in clots. Hydrobromate, hydriodate, nitrate, and sulphate have also been obtained by the action of the acids on the free base. The action of reducing agents on the triphenylic rosaniline and the methylic, ethylic, and amylic derivatives of the base have been described in the valuable memoir to which we have referred.

Putrefaction.—M. Pasteur, in continuing his researches on this subject, has presented an essay to the Academy, in which he shows that this process is, like that of fermentation, brought about by the influence of two distinct sets of beings;—one set, including *Monas crepusculum*, and *Bacterium termo*, lives upon oxygen, which it replaces by carbonic acid;

the other, including six species of vibrios, does *not* require oxygen, and indeed ceases to exist if exposed to this gas. The second is the true ferment of putrefaction. He proposes two new terms by which to designate these distinct classes of beings—*Aërobia* and *Anaërobia*, the first signifying that the beings included by it possess the power of living when exposed to ordinary air, the second expressive of an inability to exist under those conditions. He suggests also that the latter be termed *Zymics* (ζύμη, a ferment), from the property they have of developing putrefaction; and that the former be negatively styled *Azymics*.—*Comptes Rendus*, 26.

Discovery of the Metal Thallium.—We find that Mr. Crookes, in a letter to the editors of the *Philosophical Magazine*, has ably defended himself from the insinuations and assertions of M. Lamy, to the effect that thallium had not been discovered in the first instance by Mr. Crookes. English chemists are aware that since an early period in the year 1861 Mr. Crookes has devoted his attention to this subject, and that in the month of April in that year he announced "the existence of a new metalloid, probably of the sulphur group" (*Philosophical Magazine*). Now, it appears that M. Lamy has been also engaged in the study of this metal and its compounds; but, on his own admission, he did not commence his researches till *fifteen* months subsequent to the published investigations of Mr. Crookes: this, however, does not prove anything as to the priority of *isolation* of the *metal*. Not so, however, the facts disclosed in the communication to the July number of the *Philosophical Magazine*, in which the whole matter is dealt with in a most impartial spirit. M. Lamy read a paper before the Société Impériale, at Lille, on the 16th of May, 1862, in which he described thallium as a metal. This was his first communication, and, by a reference to the *procès-verbaux* of the society, we perceive that *his* discovery of the *metal* was made at some period between the 2nd and the 16th of that month. We have also the evidence of Mr. Quin* to the effect that on the 7th of June in 1862, M. Lamy, when at the International Exhibition, showed him an ingot of the metal. This, then, is M. Lamy's case. On the other side we have a letter, dated 17th April, 1862, from Mr. Quin to Mr. Crookes, stating his desire that a specimen of the metal thallium should be exhibited. If more convincing proof of Mr. Crookes's claims be necessary, we have the fact that a specimen of the metal was displayed at the opening of the Exhibition, on May 1st, 1862, and that there was affixed to the specimen a card with the following inscription:—"Thallium: a new metallic element, discovered by means of spectrum analysis. . . . It appears to have the characters of a heavy metal, forming compounds which are volatile below a red heat. It is reduced from its acid solutions by zinc, in the form of a dense, black powder, difficultly soluble in hydrochloric acid, readily soluble in nitric acid," &c. The only conclusion deducible from these facts is this:—Mr. Crookes had *exhibited* the metal at least *sixteen* days before M. Lamy announced his discovery of it and exhibited it to the society at Lille.

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* Ex-superintendent of classes 2, 3, and 4, International Exhibition.

Spontaneous Conversion of Gun-cotton into Pectic and Parapectic Acids.—Under this title a very interesting paper, by Professor Divers, appears in the journal of the Chemical Society. The discovery was, in part, the result of accident. A quantity of pyroxylin which had been prepared from Swedish filtering paper, and which was quite free from adhering acid, was exposed for about two years to the influence of *diffused* light. When the bottle was opened at the expiration of this period a quantity of gas escaped with violence, and the fumes of nitrous acid were developed. Having been left by for a considerable time, with the orifice of the bottle partially closed, the contents deliquesced into a consistent jelly. The gelatinous material was then submitted to repeated washings, which were of an exceedingly acid character; both jelly and washings were preserved, and from their conduct with various reagents the author has arrived at the conclusion that the former was *pectic* and the latter parapectic acid.

The Origin of Nitrites.—In a comparatively recent communication to the Academy of Sciences of Munich, M. Schoenbein put forward a very valuable explanation of the mode in which these salts are formed. "If pure water be boiled in an open vessel—a porcelain capsule, for example, and a few grammes of the vapour thus formed be condensed by holding over the vessel a cold flask or a sheet of filtering-paper saturated with distilled water, a liquid may be obtained which, when acidulated with sulphuric acid, gives a feeble but appreciable stain to starch solution containing iodide of potassium." This reaction, M. Schoenbein asserts, is due to the presence of a small quantity of nitrite of ammonia. The same results are arrived at more decidedly when paper steeped in a solution of potass has been employed. And this effect is also produced when the water is evaporated at a much lower temperature, as, for example, 40° or 70° per cent. If water be evaporated at 40° or 50° during a period of twenty-four hours, and that the condensed vapour be continually poured back into the retort, it will be found that at the end of that time the liquid contains a large quantity of nitrites. The author showed that even at the ordinary temperature the same formation of nitrites occurred. These salts are converted, through the action of ozone into nitrates, and hence if potash be present ordinary saltpetre will be formed. It follows from this discovery that soils—particularly those of warm climates—are being constantly supplied with ammoniacal salts; on this account M. Schoenbein says there is much reason to believe that Baron Liebeg is correct when he states that it is useless to furnish plants with a large quantity of ammoniacal manure, inasmuch as it is only necessary to supply the purely mineral ingredients of soils. M. Schoenbein supposes that plants must also contain nitrites in large quantities. He finds that the freshly-pulled leaves of *Leontodon taraxacum*, bruised and mixed with water in the proportion of one part by weight of leaves and a hundred of water, form a liquid which, when acidulated with sulphuric acid, gives a deep blue with the iodide of potassium and starch. The leaves of the following plants possess similar properties:—*Lactuca sativa*, Senecio vulgaris, S. erucæfolius, Dactylis conglomerata, Plantago major, Mentha piperita, Thymus serpyllum. Spinacia oleracea, Datura stramonium, Hyoscyamus niger, Nicotiana tabacum, Helianthus annuus, and Papaver somniferum, exhibit

a similar reaction, but only after from twelve to twenty-four hours' maceration in water.

As bearing upon the above researches, it may be stated that Professor G. C. Schaeffer has contested M. Schoenbein's right to priority in putting forward the views we have alluded to. He states (*Silliman's American Journal*) that in the annual report of the Smithsonian Institution for the year 1861, a report appears on nitrification presented to the institution in 1856, by Dr. B. F. Craig, from which the following passage is extracted:—"This action takes place very commonly with those substances which are produced from ammoniacal salts by the separation of the elements of water, and may be effected under the influence either of acids or alkalies, *and sometimes by the action of water alone at very high temperatures*. . . . . In the case of nitrogen it may be represented thus:—

$$N_2+H_4O_4=NO_4NH_4"$$

Quantity of Carbonic Acid in the Atmosphere.—M. Mène has addressed a note to the "Académie des Sciences" upon this subject. He gives the following as the results of his analytical investigations:—

1st. That the quantity of carbonic acid contained in the atmosphere is variable.

2nd. That there is nearly an equal quantity of carbonic acid present during the months of December and January; that this gas increases in February, March, April, and May, but diminishes from June to August; that it again increases from September to November, attaining its maximum for the year in October.

3rd. That there is always more carbonic acid present during the day than during the night.

4th. There appears to be some oscillation as to the quantity of this gas during the day; this takes place about noon, when a slight increase is observed.

5th. That *after* rain carbonic acid is always more abundant than *before* it.

The Detection of Wood-spirit in Essences, Tinctures, &c.—It is well known that in certain cases essences and tinctures are prepared with this spirit instead of pure alcohol, hence it becomes necessary that we devise some means of detecting the fraud. "Ure's test" is that which is usually adopted; it consists in adding powdered hydrate of potash to the suspected liquid, when if a brown colour be produced wood-spirit is said to be present. Mr. E. J. Reynolds (*Dublin Quarterly Journal of Science*, July) shows that this test is fallacious in some instances, owing to the circumstance that some of the volatile oils pass over in distillation and give rise to a distinctly brown tint with caustic potash in powder. He proposes the substitution of the following test:—"A small quantity of the suspected liquid is placed in a tube-retort and distilled over into a cooled test-tube; two or three drops of a very dilute solution of chloride of mercury are now added to the distillate and then excess of solution of caustic potash, and the whole well shaken. If the precipitated oxide of mercury do not re-dissolve even on warming the liquid, wood-spirit is not present."

Vanadic Acid.—In the *Comptes Rendus* for July 20th a note appears from Dr. Phipson, describing the results of several analyses of clays made with a view to ascertain the proportion of this acid present in these compounds. He states that whilst "London clay" contains only 0·23 per cent. of vanadic acid as much as 1·90 or even 2 per cent. may be found in a substance to which he has given the special name of "vanadium ochre."

The Ethers contained in Wines.—M. Berthelot continues his researches into the nature of the above. They are principally ether or vinic acids which are usually fixed and do not add to the odour; it is probable, that the taste of wine at different ages depends in great measure on their development. The peculiar vinous flavour, however, is not due to them; the principles to which this is owing may be extracted by mixing wine with ether and evaporating at a low temperature and removed from the contact of the air. The extract obtained by this process is composed of different substances. The following is its composition in Bordeaux and Burgundy wines:—

1. A small quantity of amylic alcohol.
2. An essential oil, insoluble in water (oenanthic ether?).
3. A small amount of acid.
4. A peculiar principle which reduces an ammoniacal solution of silver, and turns potash brown.

This principle is almost fixed, although slightly volatile in ether vapour; is very soluble in water and alcohol; ether removes it from water, heat alters it rapidly, and its extract is soon destroyed if exposed to the air. It is entirely distinct from ordinary aldehyde—which, according to the author, is not found in wines;—it is probably a derivative of the polyatomic alcohols, and belongs to a group of highly-oxygenated aldehydes.

5. A slightly volatile principle with a faint vinous odour, which resists the action of ammoniacal oxide of silver, and which may result from some transformation of the preceding body.

GEOLOGY AND PALÆONTOLOGY.

Human Jaw at Moulin-Quignon.—The evidence in this matter and the conclusions arrived at during the conference of the French and English *savans*, have been clearly set forth in a lengthy article in the "Natural History Review." The verdict is in support of the French opinion, that the jaw in question was not fraudulently introduced into the deposits, but is a *bonâ-fide* fossil of the same age as the beds in which it was found. It is, however, creditable to the calm and philosophic mode of weighing evidence adopted by our English men of science that Mr. Busk and Dr. Falconer have withheld their assent to such startling conclusions as those terminating the *procès-verbaux* of the commission. The grounds upon which these gentlemen found their belief that the jaw and "*hâches*" are spurious may be summed up thus:—I. With regard to the *hâches*—(*a*)

they possess a form different from all others previously found at Abbeville or Amiens; (*b*) their angles are sharper than those of any other specimens except those of La Porte Mercadé; (*c*) they presented no staining or discoloration; (*d*) they exhibited neither dendritic markings nor adherent matrix; (*e*) the great sameness of character presented by all the specimens, as though they had all been made by one or two persons; (*f*) none of the specimens were tinted with iron, although all the larger pebbles of the *couche noire* were so tinged; (*g*) the matrix of the St. Gilles specimen contained "unquestionable traces of *recent* vegetable structure." II. Of the jaw—(*a*) the black coating due to the matrix was washed off with the greatest readiness; (*b*) there was no infiltration of metallic matter; (*c*) there was no appearance of dendrites either externally or within; (*d*) the outer surface was rather smooth and quite unlike the condition in which buried bones are usually found; (*e*) the substance of the bone was firm, and when sawn gave the peculiar odour produced when the saw cuts through fresh bone; (*f*) the dentine of the tooth was white, and the enamel quite brilliant and in every way resembling that of a recent tooth; (*g*) the dental canal was lined with a layer of grey sand, which was not mixed with the black matrix, and seemed to indicate that *the bone had been at one period in a ferruginous sandy deposit;* (*h*) the mere adhesion of the particles of the black "*gangue*" to the bone did not indicate that the bone had remained in the deposit for any considerable time, as experiments proved that when this substance was applied in its soft state to any surface, no matter how smooth, it adhered to it when dry with the greatest tenacity. The above characters of the bone and tooth are remarkable when contrasted with those of bones of an earlier date than the beds of Moulin-Quignon. The human lower jaw from a gravel heap of an Ipswich coprolite bed, alluded to in the discussion, although retaining some of its gelatine, is completely infiltrated with iron; the Haversian canals being filled with red oxide, and a section of the fang proving that the dentine has been penetrated by the same metal. This demonstrates "that a human jaw, if favourably placed, is equally susceptible of impregnation with metallic matter as the bone of any other mammal." It is worthy of note, that the tooth which had been so carefully examined in London, and had been forwarded from Abbeville, was not permitted a place in the evidence, it having been insinuated by the French *savans* that it might through some error have been confounded with some other specimen. The French men of science relied almost exclusively on circumstantial evidence, and seemed to reject the intrinsic variety, which was regarded by the English as of more importance. Among those who have especially taken part in this investigation we may mention the names of Mr. G. Busk, Dr. W. B. Carpenter, Mr. Evans, Dr. Falconer, and Mr. Prestwich on the English side; and of M. Delesse, M. de Perthes, M. de Quatrefages, M. Desnoyers, and M. Milne-Edwards who presided, on the part of French science.

Ancient Shell Mounds of Scotland.—Mr. Lubbock, who has been examining these remnants, has observed a very interesting circumstance in connection with the distribution of Bivalves. In one heap, which was situated at Brigzes farm, in the neighbourhood of Loch Spynie, he found

specimens of Ostrea edulis, Cardium edule, Buccinum undatum, Mytilus edulis, Natica, Patella vulgata, Purpura lapillus, Littorina littoralis, Trochus, Anomia serpula, Tapes pullastra, and T. decussata. The presence of T. decussata in this locality is of great interest; firstly, because, according to the researches of Mr. McAndrew, it is no longer to be found further north than Carnarvonshire; and, secondly, because it shows that, whilst all our other extinct littoral species are to be seen extant upon northern shores and even towards the Arctic circle, T. decussata is withdrawing from the north to warmer southern latitudes.

Co-existence of Man with Elephas Meridionalis.—M. Desnoyers communicated the results of his researches upon this question to the Academy of Sciences, at one of its recent sittings. There are three kinds of evidence from which conclusions may be drawn:—1st. The presence of the human bones themselves; 2nd. The occurrence of objects of human industry, especially flint weapons, in the beds which contain the remains of the large mammalia; 3rd. The traces of man's hand upon these mammalian bones. Having described the character of a series of markings found on bones which he discovered near Chartres, and which striæ or markings he attributes in great part to the action of flint weapons, the author thus sums up the results of his observations:—1. The fossil bones of Elephas meridionalis, Rhinoceros leptorhinus, Hippopotamus major, of several species of deer, large and small, of numerous species of oxen, and of other mammals regarded as characteristic of the Pliocene formation, and discovered in an undisturbed deposit of that geological formation, present numerous and unquestionable traces of striæ, gashes, and incisions. 2. These notches and striæ are perfectly analogous with those seen on fossil bones of other more recent species; viz., the extinct ones accompanying E. primigenius, Rhinoceros tichorhinus, Hyæna spelea, &c.; and those still living, such as the reindeer, numerous deer, and the aurochs, found in bone caves and drift. Similar appearances have been recognised on several bones of existing species, collected in Gallic, Breton, and Germanic tombs, &c. 3. These marks upon the most ancient bones have, for the most part, the same origin as those observed on more modern ones, and can only be attributed to the action of human weapons. 4. Some other striæ of a finer and more rectilinear character, and which intersect each other, are also seen in great numbers upon the bones of the Pliocene formation in the neighbourhood of Chartres and other localities; these seem to be analogous to those seen on blocks and pebbles which have been scratched and polished by the action of glaciers. 5. The beds of Saint-Prest, unanimously recognised as Upper Tertiary or *Pliocene*, and certainly as anterior to all the Quaternary deposits containing Elephas primigenius, present numerous bones of Elephas meridionalis, and of most of the large species of mammalia characteristic of the Upper Tertiaries, upon which both forms of notches and striæ may be observed. 6. From these facts it seems possible to conclude, with a very fair appearance of probability until other more satisfactory explanations elucidate this double phenomenon more perfectly, that man lived upon the French soil before the great and first glacial period (at the same time as Elephas meridionalis and the other *Pliocene* species characteristic of

the Val d'Arno in Tuscany), and that he was contemporary with these huge animals anterior to Elephas primigenius and the other mammals whose *débris* have been found associated with the remains or indications of man in the gravels or Quaternary beds of great valleys, and in caverns. 7. Finally, the Saint-Prest beds supply as yet the most ancient European instances in geologic times of the co-existence of man with the extinct species of mammalia.

The Geology of New Zealand.—Professor Hochsetter has returned to Vienna with an immense stock of fossils collected in these islands; his collection is without doubt the most extensive which has yet been brought to Europe, and it is said that Dr. Zittel will be intrusted with the naming of the Mollusca proper and Echinodermata, whilst the labour of naming the Brachiopods, Ammonites, Belemnites, Foraminifera, and plants, will devolve on other distinguished palæontologists. The oldest fossiliferous rock in these islands is apparently of a grauwacke character, and contains in great abundance two distinct species of Monotis, M. Richmondiana and M. decipiens, and also, more sparingly distributed a species of Spirigera. The stratum next in order, as we pass upwards, contains Belemnites and Ammonites (a new species of the latter), together with a species of Ancella, a Placunopsis and other Jurassic fossils. The strata which succeed the foregoing have been subdivided into two sections, an upper and lower; of these the latter possesses no existing species, although many of the present genera,—as, for example, Ostrea, Pecten, Hemipatagus, Schizaster, Brissus, and Nucleolites: owing to the absence of any living forms, this group is correlated with the oldest of European Tertiaries. The second subdivision is most fully represented on the southern island, and is characterised by a fauna related to that of Australia at the present day; indeed, many of the species are identical with those now living. This section is equivalent to the more recent European Tertiaries.—*Vide* "Proceedings of the Imperial Geologic Institute of Vienna, 1863."

Fossil Bones from the Caverns of Toul.—In the neighbourhood of the latter locality a series of caves and fissures exist in the Oolite. M. Husson, in examining the geology of these caverns, found the following remains, whose relations were determined, through the assistance of M. Godron, at the Muséum de Nancy:—1. Several jaws of a species of bear (Ursus spelæus). 2. Femurs, humeri, ribs, vertebræ, and other remains of the same animal—undetermined. 3. Teeth and bones of a hyæna (Hyæna spelæa). 4. Numerous coprolites, probably of a hyæna. 5. The cannon bone of the hind-leg of a ruminant, probably of some deer. 6. Teeth and part of the jaw, probably of a boar. 7. Coprolites of an undetermined insectivorous animal. 8. Several portions of jaws and various bones, not yet determined, and belonging, some of them, to the diluvium, others to a modern period.—"*Comptes Rendus,*" August 10.

The Volcano of Aconcagua.—We find, from a report to the Academy of Sciences on the "Memoirs of M. Pissis," that this mountain, heretofore regarded as volcanic, is not really so at all. It is composed from the base to the summit of stratified rocks. The lowest are porphyries of the same description as those met with on either side of the Andes, and those at the

summit are—to judge from the features of the detached blocks—related to the chalk formation. It is placed in the centre of a large area, situate a little to the east of the line of the Andes, from which it is separated by a valley in which the Rio de Mendoza rises. Some syenitic rocks are found in the lower portion of the area which at the period of M. Pissis's visit was covered with snow.

Fossil Birds of the Miocenes of Central France.—M. Milne-Edwards, having compared the bird-remains of these deposits, has presented a note to the "Académie" upon their identification and arrangement. He thus distributes them :—Diurnal Raptores : Two species of eagles, one which has been described by M. Gervais, and which the author terms A. Gervaisii ; the other styled A. prisca. Nocturnal Raptores: Bubo Poirrieri, B. arvensis, and Strix antiqua. Grallatores : Totanus Lartetianus, Phœnicopterus Croizeti, Palælodus ambiguus, P. crassipes, and P. gracilipes. Natatores : Anas Blanchardii, Larus Desnoyersii, Pelicanus gracilis, and Graculus littoralis.

Cause of the Striæ on Fossil Bones.—M. Eugène Robert, in reply to the memoir of M. Desnoyers, states his belief that all the grooves, gashes, and scratches which the latter attributed to the action of the flint weapons used by an early race of men, have been produced by the implements of the artisans employed in extracting, and afterwards preparing, the fossils. His attention was first directed to this origin by a remark of a person engaged in the French School of Mines, to the effect that these markings were due to the awkwardness of those who removed the earth from the specimens. In one instance he was able (from the character of the injury) to infer, that the mark had been produced by a workman's pickaxe.

Geology of the Pyrenees.—It is not invariably the case that a palæontological examination of a series of rocks confirms all the deductions drawn from a stratigraphical survey. This, however, is true in the instance of these mountains' geology. M. A. Nogues, after making a lithological and stratigraphical survey of the Pyrenean rocks, was enabled to divide their primary sedimentary deposits into two groups, an upper and a lower. The latter, essentially schistose, and more or less metamorphic, he called Silurian ; the upper, principally calcareous, he called Devonian. The fossiliferous portion of this latter lies chiefly in the valley of Tech between Corneilla and Fillols. The beds are of a yellowish grey colour, and contain impressions of Stromatopora concentrica, Fenestrella antiqua, Favosites polymorpha, Berenicia . . . ., and Terebratula pugnus ; a fauna which leaves little doubt as to the true character of the formation.

The Vertebro-sternal Articulation of the Glyptodon.—The cause of the development of this peculiar joint in the remarkable edentate referred to, is being sought for by M. Serres. He asserts that the existence of the articulation offers no support to the Darwinian hypothesis, and adduces the following arguments (which to our mind are rather of the "petitio principii" variety than otherwise) in support of his opinions :—The repetition of the act of flexion, by which the head is drawn beneath the carapace, would of itself be inadequate to the production of a vertebral articulation. This is seen by reference to the common instances furnished

by human teratology. There is frequently found an incurvation of the vertebral column of man, at the level of the second or third dorsal vertebræ, yet in no case is there a true articulation produced. In ten cases of lumbar incurvation which the author observed, not one presented the least approach to a ginglymoid articulation. Again, M. Serres writes :—If we suppose this joint of the glyptodons to have been produced artificially, it could never have descended from one generation to another, for we find that when in man an entirely new hip-joint is produced (as in scrofulous affections, when the head of the femur is luxated, and develops an artificial cotyloid cavity) the new form is wholly individual, and is never transmitted to succeeding generations. The author then draws the conclusion that the vertebro-sternal articulation in the glyptodon was *created* with the animal itself.

Relation of the Aymestry Limestone to the Lower Ludlow.—In the last number of the Geological Society's "Journal" a short communication appears on this question. Mr. R. Lightbody, who has prepared a section of the Aymestry limestone at Mocktree, and who has evidently paid considerable attention to the subject, proposes that the term Aymestry limestone, as a *division*, be discontinued, for the following reasons :—(*a*) There is a constant intercalation of calcareous beds from the top of the Aymestry limestone to the bottom of the lower Ludlow. (*b*) A large proportion of the Aymestry limestone fossils are identical with those of the lower Ludlow. (*c*) The lower Ludlow star-fish are found above the whole thickness of the Aymestry workable limestone. (*d*) It is impossible to say *exactly* where the one formation begins and the other ends. (*e*) The Aymestry, or thick limestone, does not exist through large tracks of the Ludlow rocks, but only where certain fossils are very abundant.

MECHANICS.

The Suez Canal.—Mr. Hawkshaw, at the instance of the Egyptian Government, has examined the works in progress for the construction of the great intermarine ship canal at Suez ; and in an elaborate report, favourable to the enterprise, gives reasons for reversing the verdict of impracticability pronounced by Mr. Stephenson and other engineers, and generally accepted in this country. The fact was ascertained, in a survey undertaken by the advice of Mr. Stephenson, that there was no absolute difference in the mean levels of the Red Sea and the Mediterranean, and he thence concluded that the canal would have no current, and would, in course of time, become stagnant and silt up. He also supposed that the entrance to the canal at Port Said could not be kept open by any reasonable expenditure of money, in consequence of a drifting of sediment, brought down by the Damietta branch of the Nile eastwards along the coast. There is now no doubt that these inferences were crude and hasty. Mr. Hawkshaw shows that the difference in the rise of the tides in the two seas (viz., for equinoctial spring-tides, 3·67 feet at Suez, and only 0·42 feet at Port Said), would cause an alternating current which may

reach a maximum velocity, in some cases, of four feet a second, and which may be supposed capable of removing all the sediment carried or blown in. So also the large evaporation from the surface of the Bitter Lakes and Lake Timsah will cause an influx of water from both seas into the canal; and the outflow from Lake Menzaleh can, if necessary, be directed into it, at its northern extremity. Mr. Hawkshaw has also calculated the probable rate of deposition of sediment from water flowing in, and the probable shallowing from air-borne sand, from which data he estimates that the cost of maintaining the canal by dredging could not exceed £15,000 annually. After careful investigation, he attributes little weight to the objection raised on the supposed eastward drift of Nile deposit.

Experiments on Armour-Plates.—We have noticed from time to time the experiments at Shoeburyness on the resistance of iron plates to projectiles. It may now be assumed that the laws of resistance to the impact of projectiles at high velocities are approximately determined, and the most suitable qualities of the iron plates ascertained. There remain various questions as to the most suitable mode of supporting the armour casing, so as to offer the greatest resistance to shot, and at the same time to preserve the strength and sea-going properties of the vessel unimpaired. In July, experiments were made on a target constructed on the plans of Mr. George Clark, in which the armour-plates are attached by dove-tailed slots and bolt-bars to a backing of wrought-iron webs, forming a cellular system, the spaces of which are filled by pitch pine, teak, or millboard. This target resisted, with partial success, the blows of shot from the 68-pounder smooth bore and 110-pounder rifled Armstrong guns, but succumbed to the 300-pounder projectiles fired with charges of 50 lb. and 35 lb. of powder. These last smashed clear through $5\frac{1}{2}$-inch armour-plate, backing, and inner skin.

The Iron Plate Committee have reported that armour-plates should be bent, for ship-building purposes, at a bright red heat; thus, for the present, settling a question on which there has been wide divergence of opinion. So treated, with precautions which they point out, the quality of the iron will, in their opinion, be improved rather than deteriorated.

Destructive Effects of Projectiles.—Sir William Armstrong stated, in his address to the British Association for the Advancement of Science, at Newcastle, that, in conjunction with Captain Noble, he was prosecuting experiments to determine the waste of energy due to the disruption of the shot, by observing the increase of temperature of the fragments after impact. The mechanical force imparted to the shot by the ignition of the powder is reconverted into heat when its motion is arrested by impact, and this heat is divided between the object struck and the shot. By calculating from its velocity the work stored in the shot on leaving the gun, and ascertaining by Joule's equivalent the work remaining in the fragments of the shot as heat, the proportion taking effect on the shot instead of the armour-plate can be determined. The experiments showed an enormous absorption of power, caused by the yielding nature of the materials of which projectiles are usually formed. As we before pointed out, the superior efficacy of steel over cast-iron shot is due to the less proportion of work thus wasted.

Boiler Explosions.—The Astronomer Royal communicated to the British Association an important paper on the percussive theory of boiler explosions, to which reference has previously been made in these pages. According to that theory, the destructive effects observed in boiler explosions are not due to the pressure first causing rupture, but to the subsequent sudden generation of steam in the heated mass of water, from which the pressure has been removed. Professor Airy has obtained, from data furnished by the experiments of Professor Miller of Cambridge, an accurate numerical expression for the destructive energy of the steam. He concludes that, in the case of a boiler working at 60 lb. pressure, each cubic foot of water has the same destructive energy as a pound of gunpowder. Now, many boilers in use contain 500 cubic feet of water; hence the fearful devastation caused by their rupture may be imagined. An important practical deduction from Professor Airy's calculations, is that the destructive effects of a boiler explosion are proportional to the quantity of water in the boiler.

Trial of Steam Fire-Engines.—A competitive trial of steam fire-engines took place at the Crystal Palace. Steam was raised to 100 lb. pressure, starting from cold water, in from 10¼ to 17 minutes by different engines. The experiments comprised:—(First Trial)—Delivery of 1,000 gallons into a tank 67 feet distant and 27° from the horizontal, commencing with cold water in the boiler. (Second Trial)—Like the first, but commencing with steam at 100 lb. pressure. (Third Trial)—Delivery through 440 feet of hose into a tank, through an aperture 9 feet in diameter, placed 40 feet horizontally and 40 feet vertically from the nozzle. (Fourth Trial)—Vertical discharge, in which two of the engines attained a height of 180 feet. The results are given in the following table, calculated by a correspondent of the *Engineer*, from the official tables:—

Makers.	Weight.	Heating surface.	Gallons delivered per min.			Gallons per min. per sq. ft. of heating surface.			Gallons per lb. weight of Engine.		
	lbs.	sq. ft.	1st Trial.	2nd Trial.	3rd Trial.	1st Trial.	2nd Trial.	3rd Trial.	1st Trial.	2nd Trial.	3rd Trial.
Merryweather ..	6594	207	103	321	216	·49	1·55	1·01	·0158	·0492	·033
Shand & Mason..	6412	128	97	333	122	·751	2·6	·95	·0151	·0519	·019
Easton & Amos..	6592	210	159	..	..	·757	..	..	·0241	..	..
Bull & Co.	6052	200	147	327	254	·73	1·63	1·27	·0243	·054	·0419
Roberts	4400	141	49	..	91	·34	..	·64	·0111	..	·0206
Shand & Mason..	3304	62½	185	176	135	2·9	2·8	2·1	·055	·053	·041
Merryweather ..	3490	64½	108	159	81	1·6	2·4	1·2	·031	·046	·023
Lee & Co.	3360	166	165	172	71	1·5	1·6	0·66	·049	·051	·021

MEDICAL SCIENCES.

Absorptive Power of the Healthy Human Skin.—This is a very serious question, especially as regards Continental practice. The absorption of medicaments has been for a long time under the consideration of M. Delore, who now makes known his opinions on the subject. He believes that the healthy skin is capable of absorbing all substances soluble in

water, but that this absorption is too irregular to be depended on as a method of introducing medicines. The absorption is favoured or retarded by several circumstances: for example, it takes place most readily in young persons, and is effected more completely in places where the skin is thin, as the neck, axilla, &c., than where it is more dense, as the back and limbs. The extent of surface and the length of time during which friction is made have also much to do with it. The nature of the medicine has a decided influence; insoluble substances, with the exception of mercury, being never absorbed. When irritant mixtures, such as the alkalis and alcohol, are applied to the skin, the absorptive power is increased, in great measure owing to the solution of part of the epidermis. The absorption is also intensified by the employment of unctuous materials—not by any special influence they possess, but because they allow the friction to be more effectually carried on. In experimenting on the absorptive properties of the lungs, he found these organs took in but a small quantity of iodine, and that neither mercury nor belladonna was absorbed by them.—"*Comptes Rendus*," August 3.

Influence of the Nerves upon the Sphincters of the Bladder and Anus.—A series of vivisections have been made at M. Claude Bernard's laboratory by Messrs. Giannuzzi and Nawrocki, in order to determine the influence of the nerves supplying the above parts. Having injected acetate of morphia into the jugular vein of a dog for the purpose of rendering it insensible, they exposed the bladder by means of an incision into the abdominal walls, and they tied the rectum, to prevent the descent of fæcal matter; finally they tied one ureter and introduced into the other a canula provided with a stop-cock, which was connected by an india-rubber tube with a funnel filled with water, at from 30° to 35° centigrade; the funnel being fixed on a vertical sliding stem, graduated in centimetres. In this way they were enabled to calculate the exact pressure of the water, by knowing the height from which it flowed. Water having been allowed to flow into the bladder, it was found that, in order to produce a continuous flow from the *urethra*, it was necessary to have the pressure of a column of water 63 centimetres; this was before the section of the nerves. The nerves supplying the bladder were then divided, and it was found that a column of 34 centimetres produced a continuous stream from the urethra. Now, as this column is also required to produce the flow after death, it is evident that the power of so-called tonicity of the sphincters is due to the influence of the nerves. An exactly similar experiment was made on the anus, and the same result obtained, thus proving incontestably that the action of these sphincters ceases when the nervous supply is cut off.

Marriages of Consanguinity.—The conventional ideas regarding the results of these unions are likely to receive a severe blow from the memoir recently laid before the French Academy by M. Seguin. The author is fully convinced that marriages of the above kind are not followed by any consequences other than those to which all unions are liable. In proof of his view he gives a table in which are set forth the names of twenty members of his own family who intermarried; and, to judge from the scheme, the results are not at all alarming. In one instance we find two cousins marrying, and being blest with ten olive-branches; whilst in

another instance, when an uncle and niece constituted the happy couple, we observe that no less than six children were born.

The Skin of the Hands and Feet.—Anatomists are aware that the epidermis of the palmar and plantar surfaces is the only portion of the integument which is not supplied with sebaceous glands. This absence of the oily secretion confers certain properties on the skin which it would not otherwise possess, for M. Parisot has shown that the epidermis of the hands and feet is the only superficial portion of the body through which water alone is absorbed. In proof of this, the following experiment was made. The body of an infant, twelve days old, which had been washed with warm water and dried, and whose *anus*, *umbilicus*, and *urinary meatus* had been coated with Venice turpentine, was plunged in a bath of water at a temperature of about 10 centigrade. The water was constantly renewed, and the body was so placed that the head was just above the water. After twenty-four hours it was taken from the bath. Prior to immersion it weighed 2,050 grammes; it now weighed (after careful drying) 2,055, showing an increase of five grammes, the result of absorption, for on being exposed to the atmosphere for a single day it was reduced to its former weight by evaporation. This experiment merely proved the absorptive power of *some* part of the *skin*. He next smeared the palms and soles of an infant with Venice turpentine and placed it in the bath, but on removing and weighing it after three hours' immersion he found it had undergone no change in weight; thus proving that the absorption of water takes place only through the skin of the hands and feet. To demonstrate the action of the sebaceous matter, he performed another experiment. Having covered the palms and soles with turpentine, and removed the *epidermis* of the neck, he placed the infant in the bath as before, and found that, after three hours' immersion, a quantity of water equivalent to about ten grammes had been absorbed. In order to produce absorption of medicines by other portions of the integument, it is necessary to employ previously some fluid capable of dissolving the sebaceous secretion, and thus of affording a free passage to the substance. The writer observes: "I dipped a piece of cotton in a solution of atropia in chloroform, and applied it to the forehead; in three minutes there was distinct dilatation of the pupil, and in about five minutes the enlargement was complete; the application was left on for about a quarter of an hour, and produced redness and heating of the skin. In an hour after, all signs of inflammation had disappeared." When an aqueous solution of atropia was similarly applied, no dilatation of the pupil was manifest.

Growth of Bone.—M. de Lamballe *appears*, in the course of his extensive researches on the generation and reparation of tissues, to have corroborated the assertions of M. Flourens. (1) That the bones increase in thickness by external and superimposed layers. (2) That they increase in length by the addition of terminal layers arranged in juxtaposition. (3) That proportionally as the new layers are deposited externally, the older ones on the inner surface are resorbed. (4) That ossification consists in the regular and successive conversion of periosteum into cartilage, and of cartilage into bone.

Lymphatics of the Kidneys.—At a late meeting of the Vienna Academy

of Sciences, M. Ludwig announced that, having been assisted by M. Zawarykin in his investigations, he had been able to trace the lymphatic vessels to their origin, in the spaces between the tubuli uriniferi and the bloodvessels.

Products of Respiration.—To complete the researches undertaken by Regnault in 1849, M. Reiset has performed several experiments upon the ordinary domestic animals of a farm. The apparatus employed resembled that which was used by M. Pettenkofer, and, like the latter, M. Reiset has found that pure hydrogen and a hydro-carbon were exhaled by the lungs. In sheep the whole of the oxygen which disappeared was found in the carbonic acid; nitrogen was also given off, and a still larger quantity of a hydro-carbon. This latter is produced, according to M. Reiset, in all ruminants, and is dependent on certain phenomena of digestion, for he has found that a hydro-carbon exists in large quantities in the stomachs of ruminants that have died from meteorization (hoove). In rabbits the products of respiration are nearly the same. Pigs present so many irregularities that it is difficult to frame any generalization on the gases exhaled by their lungs. In geese and turkeys, nitrogen and carbonic acid were evolved, *but neither free hydrogen nor a hydro-carbon was found as a product.*

Action of Electricity on the Blood.—M. Bollet, of the University of Vienna, asserts that on passing an electric current through blood, this fluid from having been opaque becomes quite transparent, assuming at the same time a brilliant lake hue. The action is of course upon the blood corpuscles, which from the complex phenomena they exhibit when submitted to electric influence and observed beneath the microscope, the author does not suppose to possess the structure ordinarily assigned to them. His observations are in direct opposition to the doctrine of the cell-nature of these bodies.

Presence of Bacteria in the Blood.—During the last six months a great deal of controversy has taken place regarding the presence of these beings in the blood of animals labouring under certain forms of disease. These singular productions were first noticed by Fuchs in 1848, and were again described in 1860 by Delafond in the "Bulletin des Séances de la Société des Vétérinaires;" and have since that period commanded the attention of French *savans*. M. Signol has almost decided the question in his late memoir. He has found Bacteria in the blood of the horse when suffering from typhoid fever, influenza, &c.; and in one case he detected their presence in the blood of an animal which died from gangrene, the effect of a wound inflicted with a scissors. When blood containing these organisms was introduced into the system of a sheep, death followed in a very short time, and there were found in the blood of the poisoned animal, globules of a regularly-rounded form, but larger than the normal white globules, which they slightly resembled; they were united in clusters and were very abundant. They consist of an external cell of a violet tint, in the centre of which may be seen several nuclei with a well-marked double contour, and which in some instances have an almost hour-glass form. The blood-globules usually disappear, and in their place are found crystals of various forms, resembling those of cholesterine. The cells of the liver are almost invisible, owing to the fatty globules by which they are

surrounded; and the striæ on the muscular fibres are imperceptible from the same cause. The author concludes by stating—1st, That Bacteria are not peculiar to animals affected by certain diseases (*sang-de-rate*, &c.). 2nd, That the blood which contains them is inoculable, and that in the blood of animals thus inoculated, Bacteria may be found in abundance. 3rd, That the presence of fat in the tissues and liquids of the system, and the resemblance of these Bacteria to those produced during butyric fermentation, favour the presumption that fat plays a very important part in the progress of the disease.

Catheterism of the Duodenum.—Four cases in which this operation has been successfully performed, have been brought under the notice of the French Academy. M. Blanchet, who recommends the operation, thinks that it will furnish us with a means of determining the intestinal contractions, and that it will materially assist in the diagnosis of organic affections of the pylorus and intestine: intussusceptions, tumours, occlusions, foreign bodies, &c. By it we shall be enabled to convey nutritious matters, or medicines which would not be tolerated by the stomach, to the pyloric orifice. And we can employ it to remove gases which sometimes accumulate in the intestine and produce serious results.

The Poisonous Action of Thallium.—It is well that our readers should know that the *sulphate* of the new metal is a violent poison, which affects the stomach and intestines somewhat in the same manner as the salts of lead. M. Lamy records that five grammes of this salt (which is very soluble) poisoned no less than eleven animals, viz.: two fowls, six ducks, two young dogs, and a bitch. The dogs, which were more closely observed than the others, laboured under violent lancinating pain in the gastric region, which was relieved by pressure. The pains succeeded each other with rapidity, and produced effects like those of electric shocks, and then gave place to paralysis, affecting the posterior limbs. The post-mortem examination showed no evidence of lesion, and the only peculiarity observable was a very distended condition of the gall-bladder. The poison was detected in almost all the tissues by means of the spectroscope, the peculiar green band of the spectrum being quite perceptible. It is remarkable that the salts of this metal are almost tasteless, a circumstance which enhances their dangerous properties as toxic agents.

Use of Oxygen Baths in the Treatment of Senile Gangrene.—Medical men are aware that Professor Laugier has been ever the zealous advocate of the oxygen bath. He has now found a formidable opponent in M. Demarquay, who states that on various occasions he has had recourse to oxygen baths in the treatment of this form of gangrene, but invariably without any successful result. Nevertheless, he considers that oxygen *gas* may be of some service, for in cases where the gangrene has not attacked the very muscular portions of a limb, the oxygen preserves the tissues, and prevents the exhalation of fœtid liquids, and consequently of the odours which arise from them; and although in many cases it increases the pains, yet in one instance it removed them *instantly*.

Geranium Maculatum an Astringent.—The styptic properties of this plant, although familiar to American physicians, are little known to English practitioners. Its astringent powers rank very high, and from

the absence of nauseous taste and offensive smell it is calculated to be of service in cases where, owing to the existence of a weak stomach or natural idiosyncrasies, other drugs cannot be administered. As a medicine, it equals kino and catechu in its effects; and has been found extremely useful in cases of diarrhœa, dysentery, cholera infantum, hæmorrhages, gleet, leucorrhœa, &c. Its active principle is called geranin; there are also the following preparations: resinoid extract, decoction, infusion, tincture, and powder of the rhizome, the dose of the latter being from *twenty* to *forty* grains. The rhizome appears to have been always employed by the Indians as an astringent agent.—*Vide* "Pharmaceutical Journal," vol. v. No. 1.

Compounds of Iron with Albumen.—It is strange that medicines of this description were not devised long since, inasmuch as the composition of the blood and tissues seems to indicate that such compounds as the above would be useful as restorative hæmatics. Mr. E. R. Smith has at last supplied the want, and publishes three formulæ for the preparation of as many salts, viz.: albuminate of iron and soda, albuminate of iron and potassa, and albuminate of iron, soda and potassa.—("Journal of Pharmacy.")

METALLURGY, MINERALOGY, AND MINING.

METALLURGY AND MINING.

Manufacture of Magnesium.—A series of improvements in the processes for the preparation of magnesium has been patented by Mr. Edward Sonstadt. The modifications which he proposes relate chiefly to the method of preparing the magnesia from which the metal is to be obtained; to the preparation of an anhydrous compound containing magnesium, sodium, and chlorine; and to the employment of iron vessels for the reduction of the metal. There is not so much originality in Mr. Sonstadt's "improvements" as his specification would lead one to suppose, and in consequence of this, there has been some controversy upon the subject, in the chemical journals. The method he adopts may be thus described. Pure magnesia is first prepared by precipitating the sulphate, with carbonate of soda, and repeatedly washing in boiling water and drying the precipitate till the washings give no perceptible reaction with chloride of barium. To the magnesia thus obtained hydrochloric acid (free from sulphuric) is added till a small quantity of magnesia is left undissolved. After boiling and filtering, chloride of sodium is added to the solution, in the proportion of 0·55 lb. to every pound of the acid, of sp. gr. 1·152, and the mixture is evaporated to dryness in a silver dish. The dried residue is then placed in a platinum crucible, loosely covered, and heated to redness. When fully fused, it is poured out on a *clean cold iron* plate, and the cooled mass is then termed "material" by the inventor. This material is next placed with sodium in an *iron* crucible and heated to full redness, the cover of the vessel not being removed till the latter is quite cold. The cooled mass is then washed with water to

remove the contained salts, and magnesium, more or less pure, remains behind. Mr. Sonstadt directs that the metal thus produced be immediately dried at a temperature of 212° Fahr., and purified by fusion in anhydrous chloride of magnesium.

Preparation of Antimony.—The sulphide of this metal is thrown upon a furnace so arranged that the fumes proceeding therefrom are allowed to mix with the air and are collected in condensers. The vaporised sulphide is decomposed, the sulphur passing off as sulphurous acid, whilst the oxide is deposited upon the surface of the condensers. The metal is abstracted from the oxygen compound, by being mixed with carbonaceous and alkaline matters and smelted in a furnace constructed for the purpose. The above process has been patented by Mr. B. Todd of Falmouth.

State of Carbon in Cast Iron.—This is the subject of a very interesting communication by Mr. Crossley to the *Chemical News* of July 25th. The author objects to the views generally received relative to the condition of carbon in cast-iron. He believes that it is always in chemical combination and never mechanically mixed with the metal; and selecting *grey* iron as an example of what is supposed to contain graphite uncombined, he adduces the following arguments in support of his views:—1. Grey and white iron contain the same per-centage of carbon; when the former is melted the graphite is admittedly in solution, yet on cooling it is deposited. (?) Such is not the case with white iron; why should this be, when we know that both contain the same quantity of the carbon (4 per cent.), and that, as Faraday has shown, iron is capable of combining with 6·00 per cent. of this element? 2. When a little sulphide of iron is added to melted grey iron, graphite is instantly liberated, thus implying the existence of a chemical rather than a mechanical combination. 3. When grey iron is acted on by acids, carbon is lost in the form of volatile carbides of hydrogen, an oily matter being simultaneously developed. 4. By exposing a bar of *wrought* iron to a high temperature and allowing a current of coal-gas to play upon it, it is gradually converted into grey iron; if grey iron contains solid flakes of graphite, how can they possibly enter the bar under these circumstances? Mr. Crossley explains the differences in physical aspect between white and grey iron, on the supposition that both varieties are carbides of iron mixed with the pure metal, manganese, silicium, calcium, &c., and that the grey is a higher carbide than the white.

Purification of Copper.—It has been found that iron is almost invariably present in all copper, and that even cupric salts are not free from traces of the chalybeate, whose presence accounts for the greenish tinge of certain compounds of this metal. An excellent process which has been devised by MM. Millon and Commaille for the complete purification of copper, is as follows:—The metallic copper is treated with commercial sulphuric acid which has been diluted with half its volume of water; it is then boiled till sulphurous acid ceases to be disengaged and till all the copper is dissolved. The copper which is crystallized from this solution does not contain arsenic, although the latter may have been present in the sulphuric acid; but it almost always contains iron, and not unfrequently zinc also.

The sulphate procured by this process is dissolved in acid, the platinum electrodes of a pile are introduced into it, and the current being properly regulated, the metal is deposited in flexible homogeneous plates. The copper thus prepared is *absolutely* pure, and the most precise tests fail to discover the slightest trace of any foreign substance.

Preservation of the Iron Plates of Ships.—Dr. Grace Calvert has contributed an article to the *Chemical News*, for Aug. 29, which contains a description of a most important discovery. He finds that when iron is coated with zinc, or, in other words, galvanized, its capability of resisting the corrosive action of both salt and distilled water is thereby intensified. Plates of iron three inches square were attached with great care to pieces of oak of the same surface, and similar plates of galvanized iron attached in the same manner were submerged in both distilled and salt water, and allowed to remain there from March, 1862, to May, 1863. When at this period the iron plates were carefully removed, washed, dried, and weighed, the following results were obtained :—

		Loss by Corrosion, in grammes.
Pieces of wood and iron	in distilled water	1·700
	in salt water.....	4·320
Pieces of wood and galvanized iron	in distilled water	0·500
	in salt water.....	0·780

The loss occasioned by the employment of ungalvanized iron does not depend on the corrosion alone ; the iron enters into combination with the gallic and tannic acids of the oak, and thus the wood decays, or undergoes eremacausis. The coating of zinc is not easily removed by friction. "Large bolts (galvanized) were driven into solid blocks of oak by a sledge-hammer ; the blocks were then opened, and the bolts were found not to be in the slightest degree uncoated."

Cadmium Alloys.—Mr. Abel, of Chancery Lane, London, has patented a method of forming alloys of this metal with gold, silver, and copper. Those with the two latter are said to possess the property of ductibility in a high degree, whilst those with gold are capable of being employed in jewellery, owing to the beauty of their colour.

Boring Machines.—The great difficulty which was presented by the old forms of borers, viz., that of removing with the augur the whole of the rock which it was necessary to bore, has been got rid of by M. Leschot. In his apparatus, the perforator is of an annular character, and only cuts out as it were a cylinder of rock, leaving a central solid portion, which can afterwards be removed by other means. The instrument consists in a hollow iron tube, whose outer diameter is proportionate to the required size of the hole, and whose calibre corresponds to the size of the central portion of the rock. This tool is provided at its end with a perforator carrying black diamonds ; it is given a rapid rotatory motion when employed in boring, and the powder produced by the cutting of the stone is washed away by a stream of water forced along the central hollow portion. This machine is at present undergoing trial at the St. Chamond mines.

Steel Rails.—The rails of steel prepared by Bessemer's process have been submitted to a severe test, and have realized the most sanguine expec-

tations. Rails of this description were laid down last year on the London and North-Western line, parallel with the very best iron forms, and such was the durability of the former, that they exhibited very little appearance of wear, whilst the latter had on several occasions to be renewed. The result of this experiment has been to show the directors the advantage of the steel over the iron rails; and we find that they—having agreed with Mr. Bessemer in connection with the royalty, &c.—have arranged for the production, at Crewe, of 10,000 tons per annum of the new form of rail.—Vide *The Mining and Smelting Magazine*, for September.

Reports of the Inspectors of Coal Mines.—These have just been published, and it is unsatisfactory to observe that whilst the deaths in 1861 amounted to only 943, they rose in 1862 to the alarming number of 1,133. It seems that nearly all the fatal and non-fatal explosion cases which occurred in the Yorkshire mines during the past year, were attributable to the improper employment of candles for lighting the mines, and of gunpowder for blasting purposes. A strange accident befel a man in one of the Normanton mines: he had a good and well-locked safety-lamp by him, but while working in a certain locality, his pick, in meeting a brass-lump, produced a few bright sparks, which igniting some fire-damp, he was immediately scorched.

Exports of Iron from the British Isles.—It is with much pleasure that we record a very great increase in the value of iron exported during the six months ending June last, over the corresponding six months of the previous year. From the Board of Trade returns which have been quite recently issued, we perceive that, even after deducting the decrease of £4,087 in the value of "old iron" exported this year, there is still left the very large surplus of £756,894 in the value of the other varieties—pig, bar, railroad, cast, wrought, old, steel, &c.

Silver in Copper Mines.—It is not generally known that in the copper mines of Lake Superior, silver is found in the greatest purity, forming veins which traverse the native copper, or existing in forms which have not inaptly been compared with the trunks of trees. "Its varied forms, and its extreme purity, although in conjunction with the copper, render it a subject of the greatest curiosity, both metals having been, some think, subjected to a heat that must have been equal to a refiner's smelting heat; and yet the metals are each found in perfect purity."—(*The Geologist*, vol. vi. p. 69.)

MINERALOGY.

Intimate Structure of Minerals.—Dr. Zirkel has submitted numerous thin sections of various rocks to microscopical examination; occasionally employing a magnifying power of 2,000. The following results have been arrived at:—The quartz entering into the composition of granites, porphyries, and trachytes, exhibits several minute cavities which, under the highest powers employed, appeared as minute points. Small black acicular crystals project from the sides of the vitreous cavities, which, moreover, contain a vesicle. Several empty spaces may also be observed, and owe their existence to the development of gaseous matters. The quartz in all forms of granite includes thousands of crystals of vitreous

felspar, scattered in every direction. Basalts, which to the naked eye appear perfectly structureless, are seen with the aid of the microscope to present a series of different constituent particles; and from an examination of this kind several interesting particulars relative to the decomposition of these rocks may be gleaned. Even pitch-stones have been shown to consist of clusters of beautiful needle-shaped crystals.—(Proceedings of the Imperial Academy of Vienna, 1863.)

Amblygonite.—This mineral, which until recently had been found only in Saxony, has been minutely described by M. des Cloizeaux. His specimens were some of them obtained from the State of Maine, U.S., and had been presented to him by the distinguished mineralogist, Professor Brush. "It possesses three unequally easy cleavages, which are parallel to the faces of the primitive parallelipiped, and form angles of 135°, 105°, and 88° 30′."

Reproduction of Rutile, Sagenite, Brookite, and Arkansite.—The artificial formation of minerals is a subject of much interest, and one also to which considerable attention is given nowadays. M. de Hautefeuille has been engaged in experiments with a view to produce the above compounds in their characteristic natural crystalline forms, and has succeeded almost beyond expectation. Rutile may be easily obtained by passing a stream of hydrochloric acid gas over a mixture of chloride of potassium and titanate of potass. The mixture, contained in a platinum capsule, is placed in a large earthen crucible, and is heated to redness, and the acid gas is allowed to play upon the mixture by means of porcelain tubes luted to the cover of the crucible. The titanic acid, set free and modified by the hydrochloric acid, crystallizes in clustered and connected prisms. These crystals are yellow and transparent, and present the same angular characters as those prepared by M. St. Claire-Deville from amorphous titanic acid. Their specific gravity is 4·3, a circumstance which shows their identity with rutile.

Sagenite.—If a current of hydrochloric acid gas be passed over a mixture of titanic acid, silicium and fluosilicate of potash heated to a bright redness, an immense number of minute needle-shaped crystals are formed. These crystals are of a yellowish grey, present angles of 90°, and have the same chemical composition as rutile. In fact, they are quite analogous with Saussure's sagenite.

Brookite.—If the above mixture be exposed, at a *dull* red heat, to a current of hydrochloric acid, the crystals then produced present transparent plates of a very fragile nature. Silica is not found in these crystals, but their density and form are exactly the same as those of the lamellæ of brookite obtained from the rocks of Saint-Gothard.

Arkansite.—If the foregoing operation be carried on in a vessel with animal charcoal, black crystals with triangular faces and a deeply striated rectangular face, are produced. These crystals have been shown to have exactly the same density as those of arkansite; hence the conclusion that they are that mineral, produced by artificial means.

The Nature of Jade.—Dr. Sterry Hunt, in commenting on the memoir of M. Damour, observes that the examination of this mineral and its allies furnishes us with the materials necessary for the framing of a law

somewhat similar to that in organic chemistry relating to homologous series. He says, "Meionite (3 : 2 : 1) is the most basic term known of the Wernerite series, in which the proportion of silica goes on increasing up to dipyre, the relations of whose constituents is as 6 : 2 : 1, all having apparently the same density as meionite. We might naturally expect to find a silicate which would hold the same relation to dipyre that zoisite does to meionite. M. Damour has had the good luck to discover this new silicate in a specimen of jade from China." * The following table shows its relations to the other members of the series :—

	Density.		Density.
	2·7		3·3
Meionite . . .	(3 : 2 : 1).	Zoisite . . .	(3 : 2 : 1).
Dipyre	(6 : 2 : 1).	New Jade . .	(6 : 2 : 1).

Electrical Relations of Minerals.—M. de Kobel has investigated the conducting and isolating properties of various minerals, and has communicated the following results to the Munich Academy of Sciences :—

1st.—Group of Good Isolaters. (*a*) Electro-positives : Calcite, Arragonite, Lyparite, Barytine, Gypsum, Anhydrite, Apatite, Quartz, Topaz, Smaragdite, Grossulaire, Disthene, Orthoclasse, Albite, Tourmaline, Axinite, Zinon, Moscowite, Spinelle, Alum, &c.—(*b*) Electro-negatives : Talc, Sulphur, Asphalt, Orpiment, Succinium.

2nd.—Group of Good Conductors : Graphite, Gold, Silver, Platinum, Galena, Pyrites, &c., &c.

3rd.—Group of Imperfect Conductors : Diamond, Celestine, Almandine, Melanite, Analcine, Sphene, Antimonite, Jamesonite, Franklinite, Pyrolinite, &c.

Discovery of Albertite in Scotland.—This peculiar mineral has recently been detected near Mountgerald, by Mr. A. C. Mackenzie. This gentleman has detected no less than thirty-six veins of a substance quite analogous to the American Albertite. It is to be hoped that he will continue his investigations in the same direction, for the mineral is an exceedingly valuable one, yielding as it does a very considerable quantity of a hydrocarbon oil, which, to judge from its reputed properties, bids fair to rival the much-used paraffine oil as a medium of artificial light.

The Characters of Alunite.—M. Gautier-Lacroze finds this mineral abundant in the rocks about Mount Dore. Its cohesive power is almost equal to that of quartz, and its colour, which is of a greyish white, becomes under the influence of the air, first bluish green and then reddish. It has a slightly conchoidal fracture. It is more or less spotted with small particles of sulphur, and has a density of 2·481. Yellow prussiate of potass gives a fine blue colour with it. When dried it loses ten per cent. of water. It consists of water, sulphur, potash, sulphuric acid, oxide of iron, alumina, and silicious matter.

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* For a description of this mineral, see the last number of this Review, page 568.

MICROSCOPY.

[In accordance with their true and recognized relations, it has been deemed expedient to distribute those portions of the Quarterly Retrospect embraced by the above term, among the three sections : Botany, Zoology, and Medical Science.—*Ed.* Popular Science Review.]

PHOTOGRAPHY.

THE meeting of the British Association recently held at Newcastle-upon-Tyne has been unusually attractive and successful as regards the progress recorded in several of the grand departments of science ; but it cannot be said that the practice and theoretical basis of photography have been so greatly advanced as were many other branches of applied science which came forward for discussion. The supply of papers contributed under this head was scanty, and in some respects wanting in interest ; a result attributable, we think, to the non-recognition of a special section devoted to photography and its results. There were, however, several matters brought under the notice of the sections devoted to chemistry and physical science which involved the application of photography, and wherein the resources of this art had aided in illustrating the subject : thus, the report of the Kew Committee described the arrangements employed for registering, by means of photography, the oscillations of the magnet, and the constantly varying indications of sundry meteorological instruments. The adaptation of the camera to the telescope, and the use of such apparatus in astronomical research, were likewise pointedly illustrated. The chemical properties of gun-cotton were fully discussed in an interesting report devoted to a comparison of its propulsive effects with those of ordinary gunpowder. The latest results obtained by Mr. H. Fox Talbot in his experiments upon the art of photographic engraving were exhibited, one or two of which evidenced very considerable improvement upon former specimens of the kind. Professor C. Piazzi Smyth showed a series of photographs taken from the Peak of Teneriffe, and at an altitude of about 10,000 feet ; the distinctness with which the distant landscape was rendered appeared to justify the assertion that the upper regions of the atmosphere favoured the action of the chemical rays upon the collodionized surface exposed in the camera. Mr. Glaisher's lecture on aërial investigations was illustrated by photographs taken by Messrs. Negretti & Zambra, of Hatton Garden. One of this series, showing the lecturer with his instruments arranged, and accompanied by Mr. Coxwell, in the car of the balloon, appears as though it were taken during the ascent, and just before entering the clouds ; this sketch is, however, a composition picture, the several parts being very skilfully united, and the background painted in with good effect. The Abbé Moigno exhibited some photo-lithographs, and described

the method employed by M. Marquier in their production. Mr. Henry Swan described a new and very ingenious apparatus which he has devised for optically uniting a pair of stereoscopic portraits, and so producing an image apparently solid or in relief. The principle of its construction may be gathered from the following extract from Mr. Swan's account of his instrument :—

"The union and combination of the two flat pictures (transparencies upon glass) so as to produce the true stereoscopic image, I manage by taking two rectangular prisms of flint glass or crystal, ground to an angle of about 39° or 40°. These two prisms I place together, with their widest sides in contact, or nearly so, so as to form one solid quadrangular prism, divided lengthwise by a thin film of air. Now, if I stick a blue wafer on one side of this combination, and a red one at the back, I shall find that when I look straight at this combination, the rays which reach one of my eyes are those which are transmitted directly through the prisms, so that with this eye I see the object which lies at the back. On the contrary, the rays which reach the other eye are not from the back, but from the side only, as they are reflected from the surfaces of the prisms where they touch each other. Hence, with this eye we see by reflection the object at the side, which, however, appears to be at the back, like the other. . . . . In fact, if we draw a line perpendicular to the surface of the prism next the eye, all the rays which fall on one side of that line will suffer total reflection from the inner oblique surface of this prism, while nearly all the rays which fall on the other side of this line will be transmitted direct through the two prisms."

In consequence of the images of the red and blue wafers being in this way separately presented to the eyes, it results that but one image is apparent, as in the ordinary stereoscope, and this assumes a purple hue, as the consequence of the red and blue images being superposed on each other; and if, instead of the coloured wafers, we substitute the two slightly dissimilar pictures which constitute the stereoscopic pair, we obtain, of course, the image apparently solid. A certain amount of skill is requisite in mounting the transparent pictures, so as to ensure their precise coalescence, or the eye may become distressed during their examination through the instrument.

The specimens exhibited by Mr. Swan at the meeting of the British Association were mounted in morocco cases or in gold, to be worn as charms. Some of them were coloured, and all were backed by opal glass, to assist in diffusing the light. The effect on looking through them was as pleasing as the contrivance is novel and ingenious.

Dr. T. L. Phipson, in a communication to the "Moniteur de la Photographie," explains the fact that photographic collodion usually becomes reddened shortly after being iodized, by assuming the separation of free iodine, from the salts of potassium or ammonium commonly used, to be the direct consequence of the decomposing action gradually exerted by these alkaline compounds upon the dissolved pyroxyline, the hyponitric elements of which are said to be withdrawn much in the same way as by the operation of a caustic alkali. Collodion which has been rendered sensitive by the iodide of cadmium is known to be much less liable to change; probably in consequence of this salt being perfectly neutral, and therefore unable to remove the acid constituents from the gun-cotton;

such collodion remains colourless and fit for photographic use for a very long period, and is, in this respect, greatly superior to that prepared with the iodide of ammonium. In this explanation it cannot be the author's intention to assert that the removal of the hyponitric elements is more than partial, else the ultimate product, cotton itself, would in time be precipitated from the etherial solution. No such result has yet been observed, and if Dr. Phipson's suggestion be limited to the reduction of the trinitro compound, $C_{12}\left\{\begin{matrix}H_7\\3\,NO_4\end{matrix}\right\}O_{10}$, usually employed in the manufacture of photographic collodion, to one of the lower modifications of pyloidine, containing two, or even a fewer number of atoms of nitrogen, and which are still soluble in mixtures of alcohol and ether, a feasible explanation is at once provided, and one which more nearly coincides with the facts of the case than that formerly advanced by Mr. Hardwich, to the effect that ozone was mainly instrumental in promoting this change by time.

We have already more than once had occasion to refer to the employment of the sulphocyanide of ammonium as a fixing agent, which may possibly, at no distant period, supersede altogether the use of hyposulphite of soda. The favourable report regarding its efficacy made by the committee appointed by the Marseilles Photographic Society tends to strengthen this conviction. The paramount obstacle which has hitherto stood in the way of its introduction, viz., its high price, seems likely to be soon overcome; for already M. Meynier, to whom we are indebted for the original proposal, has succeeded in producing it with such facility, that he is enabled to offer it for sale at the rate of three francs per kilogramme, which in English money is nearly equivalent to one shilling and twopence per pound.

The efficacy of ebonite as a material for photographic baths, trays, and other apparatus intended to be used in contact with nitrate of silver, has been much questioned of late, and it appears, from evidence given upon this subject by Captain Dennis Wright, Mr. J. Spiller, and others, that there are a variety of materials met with in commerce under the name of ebonite, some kinds of which appear to have been manufactured from condemned india-rubber goods, and in consequence are liable to contain bronze powders, pigments, and other metallic impurities, which exert a reducing action upon the nitrate of silver. There is, however, a better class of goods to be met with to which these objections do not apply, and it is suggested that the guarantee afforded by the name or stamp of the maker should be the guide in selecting articles of this description for photographic employment.

Dr. Phipson proposes to measure the chemical action of the sun's rays by the employment of molybdic acid, dissolved in sulphuric acid. On exposure to light this solution becomes coloured of a bluish green tint, due to the reduction of the molybdic acid to the state of an inferior oxide; whilst the oxygen, liberated from the first-named compound, is said to unite with the elements of water, producing the binoxide of hydrogen. During the night this "oxygenated water" gives back the oxygen which has been withdrawn from its combination with molybdenum, and the mixture thus becomes again fitted to undergo the same chemical change by

renewed exposure. The test solution may be prepared by dissolving about 10 grammes of molybdate of ammonia in an excess of diluted sulphuric acid; metallic zinc is then introduced until the liquid has become dark-blue, and then a solution of permanganate of potassa is carefully added until the colour is again bleached.

The state of dilution is not specified by the author, but in applying this principle to the determination of the chemical and solar intensity, it is proposed to employ measured portions (20 cubic centimetres) of the same standard solution for a like period each day—say from eleven until twelve o'clock. The amount, or rather degree, of discolouration is then estimated by gradually adding a solution of bichromate or permanganate of potassa of known strength, until the last drop restores the liquid to its primitive colourless state.

An ingenious method of printing *blue* photographs, founded upon the old Prussian-blue process of Herschel, has been devised by Mr. Carey Lea. He floats the paper for a very short time on a solution of the double peroxalate of iron and ammonia. It is then thoroughly dried in the dark, and exposed under a negative for a space of time varying from two or three minutes in the sun to twenty or thirty in the shade. On re-entering the dark room no impression is visible on the paper, but the print is rapidly developed when immersed in a mixture of four parts saturated solution of oxalic acid, one part ferricyanide of potassium, and twenty-five parts of water. After the image has acquired full intensity it only requires washing in water. The double oxalate is prepared by dissolving hydrated peroxide of iron in binoxalate of ammonia. The chief improvement consists in adding oxalic acid to the developing bath. This keeps the whole parts perfectly clean,—a difficult point to manage by the old processes.

A very pretty application of photography to the ornamenting of glass and porcelain surfaces has just now been announced as the invention of M. Beyrich, the well-known manufacturer of enamelled photographic papers, of Berlin. The process cannot yet be said to have been fully perfected, but the following details will convey a general idea of the mode of proceeding :—Positive impressions are first obtained by printing from a glass negative upon a particular description of photographic paper, the copies being made rather darker than usual, and fully toned; they are fixed in hyposulphite of soda, and subsequently well washed in water. In this last operation it will, however, be noticed that the sensitive film, or rather the actual picture, gradually separates from the substratum of ordinary paper, and ultimately becomes disengaged, floating in the water as a perfect, though extremely delicate, photographic film, which can, by careful management, be lifted upon a flat plate of opal glass, or received even upon rounded surfaces, as those of a porcelain vase. Being adjusted at once into the desired position, the photograph is then allowed to dry, and requires merely the employment of a thin coating of some transparent varnish to secure its perfect adhesion to the surface either of glass or porcelain, and, at the same time, will be sufficiently protected against injury to permit of the method being applied to a great variety of ornamental purposes. The special paper is supplied by its inventor, and its

constitution has not been made known; it appears to have been prepared in such a manner that, by the intervention of a layer of a material which is soluble in water, the attenuated upper film of collodion, or other similar substance, may be separated during immersion from the body of paper, which itself merely aids in giving strength to the tissue whilst undergoing the manipulation necessary to the production of the photograph.

With reference to the forthcoming Exhibition of the Photographic Society the council have determined upon trying to make good the deficiency of past years by charging a small rent for space to all who are not associated as members of the Society. A sub-committee has already been appointed for the purpose of securing a room or gallery for the purposes of the exhibition, and for carrying out the general arrangements connected with the undertaking. Intimation has already been given to the effect that the council will again distribute a series of prize medals for the best examples in the several branches of photographic art.

PHYSICS.

The Molecular Mobility of Gases.—Under this title we have a most valuable communication by Professor Graham, in the "*Comptes Rendus*" for July 27. The author was led to his results by a new examination of the diffusion of gases depending on this molecular mobility. When the air or other mixture of gases is placed on one side of a graphite plate, a vacuum being maintained on the other, the passage of the gases may be effected in three different ways:—1. The gases may enter the vacuum by passing through a *single* minute aperture, such as that made by a fine needle in platinum-foil. The rapidity of the various gases then depends on their specific gravity. In this case the gas in its entirety partakes of the movements of *effusion* or efflux, whilst only the molecules are affected in the case of diffusion. 2. If the efflux aperture be in a very thick plate, so as really to form a sort of tube, the effusion rates of the gases are disturbed. If, however, the length of the tube be 4,000 times its diameter, a constant proportion between the effusion rates of the different gases is observed. The gases now pass by *capillary* transpiration. "The rates of transpiration are not governed by specific gravity, and are indeed singularly unlike the rates of effusion." "The transpiration ratios of gases appear to be in constant relation with no other known property of the same gases, and they form a class of phenomena remarkably isolated from all else at present known concerning gases." 3. A plate of *artificial* graphite, which appears to be practically impenetrable to gas by either of the modes above described, nevertheless admits of the passage of gases by the aid of molecular or diffusive movements. The author found that the times of passage of various gases were quite different from anything observed in the previous instances. They bore a close relation, however, to the square roots of the densities of the respective gases. This was more precisely determined by causing the gases to pass into a Torricellian

vacuum, and consequently under the full pressure of the atmosphere. The following results are most interesting :—

	Times of penetration of equal volumes.	Square root of the density.
Oxygen	1	1
Atmospheric air	0·9501	0·9507
Carbonic acid	1·1860	1·1760
Hydrogen	0·2505	0·2502

This discovered property has led Professor Graham to the adoption of a new method of gaseous analysis, to which he has applied the special term of *Atmolysis*. By means of this process, gases intermingled may be easily separated, owing to the difference between their times of penetration. His apparatus, which he styles an *atmolysing tube*, is thus described :—"It consists of a very narrow tube of porcelain or unglazed earthenware, fixed by means of corks in a glass tube which is shorter and wider, somewhat like a 'Liebig's condenser.' The glass tube is connected with a pneumatic machine, so as to produce as perfect a vacuum as possible in the space between the two." When a detonating mixture of two volumes of hydrogen and one of oxygen was made to traverse this apparatus, it was found on emerging from the tube to contain only 9·3 per cent. of hydrogen, and did not explode on having a lighted match plunged into it. If a mixture consisting of equal volumes of oxygen and hydrogen be employed, the proportion of the latter may be easily reduced from 50 to 5 per cent. The benefits which these grand discoveries of Graham are likely to confer on the analyses of gases will be readily conceived by those who have given attention to the subject.

Liquids Adhesive to Mercury.—Mr. Gore has been making a series of experiments on this subject. He finds that if a drop of Nordhausen sulphuric acid be placed by means of a clean glass rod on a globule of mercury which weighs about eighty grains, the acid spreads itself evenly over the surface of the metal, and that the latter becomes flattened and exhibits vortical movements on its surface. A strong aqueous solution of ammonia did not produce these effects: the ammonial drop retained its spherical form and remained attached to the globule, especially when the latter was about sixty grains in weight. Mr. Gore has given a list, showing the relative conduct of various substances in regard to globules of mercury, by which we observe that acids and alkalis hold opposite places, and that water and neutral solutions are intermediate (*Philosophical Magazine*, August).

Patent Microscopic Camera. — In the *Chemical News* for August 8th, a compact instrument of the above kind is described. It has been patented by Mr. Eden, and is intended to be employed for taking *photo-micrographs* (magnified representations of microscopic objects), and *micro-photographs* (diminished representations of objects). We do not find anything, however, which we have not seen before, and are disposed to regard it in some measure as the result of that "patent mania" which has of late laid hold of our population.

Solar Rays Electric Agents.—M. Musset has communicated to the "Académie des Sciences" an additional set of investigations into the

electric action of the prismatic rays. He allowed the solar rays to play upon a delicate Nobili's galvanometer, and observed that very considerable deflections took place, in some instances amounting to 90°. He ascertained that these deflections of the needles were not the result of any change of temperature, and that they were not due to currents of air; hence, he fairly concluded, that they were the immediate result of the action of the rays themselves. When in the shade the needles remained quite immovable; but the moment that the rays were allowed to play on them, deflections took place, which were invariably greater for the violet than for the other colours.

The Numerical Nomenclature of Spectral Lines.—This is the subject of a note in a late number of the *Chemical News*, by Mr. Emerson Reynolds, of Dublin. There is a great want of uniformity in the modes adopted for the subdivision of the spectrum. The results obtained in most instances are not practically available for easy reference. This the writer attributes to the circumstances that no two prisms have identical angular values, and no two telescopes are of exactly the same magnifying power. He proposes that two clearly defined lines be taken (like the zero and boiling-point of a centigrade thermometer), and that the interval between them be divided into a hundred equal parts; in this way, at all events, a constant relative measure would be arrived at. He proposes to make Alpha in the lithium the zero, and Delta in the strontium, the hundredth division of the new scale.

The Use of Prisms of Flint-Glass and Bisulphide of Carbon for Spectral Analysis.—From the investigations of Sigmund Merz, published in "Poggendorf's Annalen," it would seem that Professor Rood's new bisulphide of carbon prism is a much more accurate and valuable instrument than was at first supposed, and also one which on account of its comparative cheapness deserves to be employed. In 1862, Professor Rood mentioned (in a letter to Professor Silliman) the discovery of two new lines in the interior of the line D, which, added to that before described by Kirchhoff, made three fine lines. The instrument he used was composed of three bisulphide of carbon prisms of 60°, with a flint-glass prism of 45°, the sum of the refracting angles being 125°, and the telescopes employed being the common French instruments. On the other hand, Merz states that with a series of *glass* prisms, the sum of whose refracting angles was 270°, he only discovered the second line in the interior of D, and failed to observe the third, which had been detected by Professor Rood.—*Vide* "American Journal of Science and Art," XXXV. 356.

The Electric Spark.—M. Daniel has been instituting a number of experiments on the spectra produced by the electric spark when generated indifferent media, liquid and gaseous. The liquids employed were:—sulphuric ether, absolute alcohol, sulphide of carbon, essence of turpentine, benzine, aniline, naphtha, chloroform, protochloride of phosphorus, distilled water, &c. The machine employed was a middle-sized one of Ruhmkorff's; balls of copper, zinc, lead, tin, cadmium, &c., were used as electrodes, and, except in the case of liquids offering a feeble resistance, short sparks of about two or three millimetres were experimented on. The spark is generally more vivid than in the air, and its colour varies with the medium

and the metal employed. In the liquids, it gives three distinct spectra—one of the metal, one of the vapour of the liquid, and, after some time, one of solid incandescent carbon. The spectra produced in gases are never very brilliant. The constitution of the electral spark is invariably the same, no matter what be the condition of the medium in which it is produced, nor whether it be liquid or gaseous. We have, generally—1st, *volatilization of the polar metal, and incandescence of the vapour produced;* 2nd, *incandescence of the elements of the medium through which the current passes.* In certain cases, the medium alone or some one of its elements appears to become incandescent; in other instances, the vapour of the metal is the luminous substance. All simple bodies which have a great affinity for the metals, whether they are free or in combinations easily decomposed, intensify the metallic spectrum.

Electrical Conductibility of Thallium.—The conductibility of this metal has been estimated, according to Wheatstone's method, by M. de la Rive. It is expressed by the formula—

$$C = \frac{L_2 D}{WR}$$

when L = length of the wire; D, the density; W, the weight; and R, the resistance. Four wires of various lengths were used, and the mean figure for conductibility was calculated at 5·30, as compared with mercury.

Absorption of Heat by Gases.—Professor John Tyndall delivered a lecture some time since in the Royal Institution, in which he showed that certain gases have the power of intercepting radiant heat to a far greater extent than has been supposed. A very simple apparatus for the purpose of determining this capacity on the part of gases, was exhibited. It consists of a hollow cylinder, closed at one extremity by a plate of rock-salt, into which was fitted a second and smaller cylinder closed in a similar manner. As the second moved piston fashion within the first, it is evident that by enclosing the gaseous matter between the two plates, a layer of any required tenuity might be obtained. The lecturer performed several beautiful experiments, which illustrated his views in the most striking manner. It was shown that a layer of olefiant gas, of a thickness of two inches, intercepts about thirty per cent. of the entire radiation. If our earth were surrounded by such a layer, the temperature would be something fearful to contemplate; for, though it would offer no decided obstruction to the passage of the sun's rays, it would intercept and, to a great extent, return thirty per cent. of the earth's radiation. It was also demonstrated that both absorption and radiation are molecular phenomena, and are not dependent on the aggregation of the molecules. If a certain vapour be a powerful radiator and absorber, the liquid from which it proceeded has similarly intense properties. The order of absorption in liquids and vapours is exactly the same.

The Specific Heat of Solid Bodies.—A memoir enunciating new views on this subject has been presented to the French Academy by M. H. Kopp. He maintains—1st, that every element in the solid state, and at a certain number of degrees from the fusing-point, has a single specific heat, and consequently a single atomic heat also; 2nd, that this specific heat is subject to certain variations, according to the physical conditions of the

simple body, its density, cohesion, crystalline or amorphous state, &c., but that these variations are *never* as extensive as those which certain specific heats would offer if all the elements followed "Dulong and Petit's" law; 3rd, that the specific heat of an element is the same, whether it be in the free state or in combination.

Motions of Camphor on the Surface of Water.—Mr. John Lightfoot contributed an article on this subject to the *Chemical News* of June 27th. There was nothing very original in the communication, and still less in the suggestion appended to it, that, owing to its peculiar properties, camphor might be used to distinguish fabrics dyed with certain colours from others prepared in a different manner. In the same journal (July 18) a letter appeared from Mr. Charles Tomlinson, whose researches on this subject are familiar to many. In this communication, several of Mr. Lightfoot's assertions are ably refuted, and it is satisfactorily proved that as early as the year 1748 the motions of camphor on water had been observed by Romeiu.

An Improved Spectroscope—Analysis of the Fixed Line D.—The following extract of a letter from Professor Cooke has been published in a late number of the *Chemical News*. The writer having described the instrument, which has nine bisulphide of carbon prisms, by which the light is bent through almost 360°, states that he has arrived at these three results:—1st. "That the lines of the solar spectrum are as innumerable as the stars of heaven," he having detected with this instrument "at least *ten times* as many lines as are given by Kirchhoff in his chart, and an infinitude of nebulous bands just on the point of being resolved." . . . . 2nd. "That the coincidences between the bright lines of the metallic spectra and the dark lines of the solar spectrum remain perfect even with this greatly increased power." . . . . 3rd. "That many of the bands of the metallic spectra are broad coloured spaces crossed themselves by bright lines. This is the case with the orange band of the strontium spectrum, and with the whole of the calcium and barium spectra to a remarkable extent."

A New Photometer.—An instrument by means of which the exact intensity of light can be measured has just been invented by M. Place. It is stated that it will enable the photographer to calculate the chemical intensity of either natural or artificial light with very great accuracy, and thus preserve him from a very common error, that of supposing that the beauty of the results obtained are due to the perfect character of some new process, when it is really owing to a more favourable light.

ZOOLOGY AND COMPARATIVE ANATOMY.

Metamorphoses of Pteromalus.—The development of Pteromalus (a small parasitic hymenopterous insect) was described some years since in the "Annales des Sciences Naturelles," by Dr. Philippi. The eggs of this creature are deposited singly in the transparent ova of a species of beetle, and when the young larva appears it is like a small animalcule, an infusorian provided with a little tail, which it whisks about rapidly; its

form, however, and the hairs which cover it giving it the characters of a dipterous larva. After a while it becomes quiescent, and a second larva is developed within it, which in its turn becomes converted into a nymph. Hence the author concluded that this was an instance of development through the medium of *nurses*, as Steenstrup termed them. He now corrects the error into which he had thus fallen, and instead of regarding it as an instance of metagenesis, he considers that the first larva passes into the second stage by a change of skin, and he therefore looks on the process as a case of hypermetamorphosis.

The Embryology of Echinoderms.—A valuable compilation with this title has been made by Professor Wyville Thomson. It includes the researches of Sars, O. F. and J. Müller, Koren, Danielssen, &c., together with the compiler's own investigations into the development of Comatula, Synapta and Asteracanthion. The end in view appears to be the endeavour to trace some common principle correlating the various modifications which are presented in the course of the developmental processes by the several members of the group. The writer regards the Echinodermata as constituting a group which is as much entitled to the designation of sub-kingdom as Coelenterata or Annulosa ; for although they exhibit a decided relationship to the latter, yet "they have maintained through the whole series of geological periods a high degree of importance, and at the same time a singular compactness as a natural group." This group presents some very remarkable points in the history of development. From a single egg two distinct organisms are produced which, apparently, have all the important characters of a true animal. These two beings are entirely different, one appearing to be related to the Annulosa, whilst the other, which is subsequently formed within the first, becomes the perfect Echinoderm. In Bipinnaria we have an instance of an organism developed from the germ-mass, and carrying on an independent life before the appearance of the genuine Echinoderm. To a production of this kind Professor Thomson applies the expression *Pseudembryo ;* and all the appendages which relate to it, even though they possess none of the characters of a perfect animal, he styles *pseudembryonic appendages.* In all Asterid germs there is a fusion of the whole or a part of the germ-mass into a layer of the peculiar structureless histological element—sarcode—which possesses, as it were, an individuality of its own quite apart from the true embryo. The writer lays especial stress upon this conclusion ; he is not content with the supposition that this layer is merely an equivalent of protoplasm ; for him, it possesses a peculiar *vital activity*, which has not been fairly recognised. We cannot see why it is necessary to suppose that it is more endowed with *special* powers than the periplast, which in one case can become a bone, and in another a sinew.—*Vide* "Nat. Hist. Rev."

A New Species of Coccus.—M. Le Mulier has addressed a note to the French Academy, announcing the discovery of a Coccus indigenous to Algeria, whose colour when bruised is like that of the insect which is familiarly known as cochineal (C. Opuntiæ), and which he thinks might with advantage be employed as a colour. It is found chiefly on umbelliferous plants, and is easily recognized on account of the beautifully white cottony down with which its body is clothed. If it were thought desirable

to use it as a dye, it could be obtained in large quantities, and would thus give an occupation to many hands unfit for heavier labour.

The Real Nature of Psorospermiæ.—These beings, which are usually parasitic on fresh-water fishes, and which were ranked by Leydig and others among the Gregarinidæ, have been placed by M. Balbiani in the vegetable kingdom. This distinguished naturalist has observed in the cavity of the transparent shell of these organisms, and towards one of its extremities, two little vesicular pyriform organs. At the point of union of these bodies the shell of the psorosperm is pierced by an aperture, which forms a communication between its cavity and the external medium. The walls of these vesicles are thick and granular, and within them may be seen a filament coiled up spirally and filling the entire cavity. These filaments are not at first easily observed, but on adding caustic potash they are seen to project as two delicate leashes. The filament is usually four times, but sometimes even ten times as long as the entire animal, and is often so attenuate at its extremity as to escape detection. M. Balbiani supposes that these filaments perform the same function in these beings as the antherozoids of other cryptogams. Moreover, there exists also in the general cavity of the psorosperm a glutinous mass or nucleus which disengages itself in propagation, and is nothing more nor less than a vegetable spore. [This relation of the Psorospermiæ to plants has been also suggested by Dr. Spencer Cobbold, in the *Intellectual Observer* for April, 1862.—*Ed.* POPULAR SCIENCE REVIEW.]

Distribution of Infusoria.—With a view to determine the species of Infusoria prevalent in the atmosphere of various countries, Mr. J. Samuelson examined the dust from rags which had been brought from Alexandria, Trieste, Tunis, Peru, and Melbourne. His investigations have led him to conclude—1st, that the atmosphere in all parts of the globe contains corpuscles belonging to the animal, vegetable, and mineral kingdoms; 2nd, the Infusoria present are chiefly germs of monads, vibrios, and kolpodas; 3rd, these organisms are more abundant in a dry than in a moist atmosphere; 4th, the tenacity of life exhibited by these germs is far greater than some observers seem to think. The author concludes with some remarks tending to show the untenability of the *spontaneous*-generation doctrines.—*Comptes Rendus*, LVII. 87.

The Air in the Swim-bladder of Fish.—M. Moreau analysed the air contained in this organ, and found it to consist of oxygen, nitrogen, and carbonic acid in proportions varying with the species and even with the individual. To ascertain the cause of these variations, he caused a certain number of the common perch (Perca fluviatilis) to be asphyxiated by immersion in water from which air had been excluded; and he destroyed an equal number of active fish by dividing their spinal chords; he then proceeded to analyze the gases contained in the bladders of both series; and he found in the first, that the quantity of oxygen present did not exceed 3·66 per cent., whilst that of the second amounted to 19·25 in a hundred parts. He considers then: "That the proportion of oxygen contained in the swim-bladder of the perch diminishes to zero when the fish is so circumstanced that it cannot abstract this element from the surrounding medium."

Crystals in the Intestines of Artemia Salina.—It has been asserted on good authority, that deposits of uric acid are frequently formed in the intestines of the larger Crustaceæ; but we are not aware that depositions of this substance have ever before been observed in the bodies of Entomostraca. The discovery of their presence in these creatures is due to Mr. H. J. Slack, who has found them in very considerable quantity in the digestive tube of Artemia. The uric acid presented the crystalline form, the prisms being arranged in aigrettes, which bore a decided resemblance to the figures of uric acid in the "Micrographic Dictionary." He found the acid in the form of amorphous masses also, and that the animals whose intestines exhibited deposits of this character were much shorter lived than the others; and he frames the following interrogatory generalization: "Does the amorphous condition indicate a rapid deposition, arising from an excess of uric acid, incompatible with the little animal's well-being?"

A New Coral.—This has been discovered by M. Grube on the Norwegian coast, and presents several interesting peculiarities. A very hard polypary, resembling red coral in character, but of a greyish-white colour, forms its axis. Its polyps are *eight-armed*, their coenanchyma being covered with calcareous scales, and their mouth being supplied with eight calcareous valvules. The polypary is not composed of calcareous matter alone, layers of true corneine of a black colour being found alternating with those of the lime substance. *En passant*, M. Grube states that corneine is not insoluble in potash, as Valenciennes and others suppose.

Breeding of Tortoises in this Country.—A female tortoise brought to this country about fifty years ago, and allowed communication with a male, introduced four years since, laid eggs in July, 1862, which have been somewhat artificially hatched, and from which two young reptiles have been developed. The female, prior to depositing the eggs and covering them with clay, was seen to make a hole some four inches in depth and having a perfectly flat bottom. In this receptacle the ova were laid, each egg being about the size of a pigeon's, and having pretty much the same appearance. "The young ones are kept in a wooden box in a pine-pit, with some earth and moss, under which they nestle. They are fond of lettuces and strawberries; but do not eat much. They appear quite well and lively, and are now (August) a little larger than half-crowns."

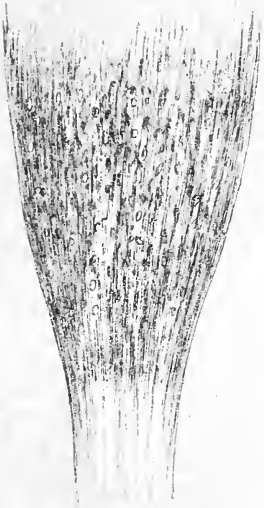
The Acclimatization of Honey-Bees.—Dr. A. Gerstäcker, in concluding a very extensive memoir on the distribution of the honey-bee, observes, that the most valuable form for Europe would be the Egyptian, partly on account of their beauty, and partly because of their unwillingness to use their stings, which appears to be common to all African bees, and is also one of the recommendations of the Italian bee. The Syrian bee agrees so closely with the Egyptian, that it may prove equally valuable; and next to these in value are the bees of the coasts of Asia-Minor.—"Annals of Natural History," 3rd Section, 65.

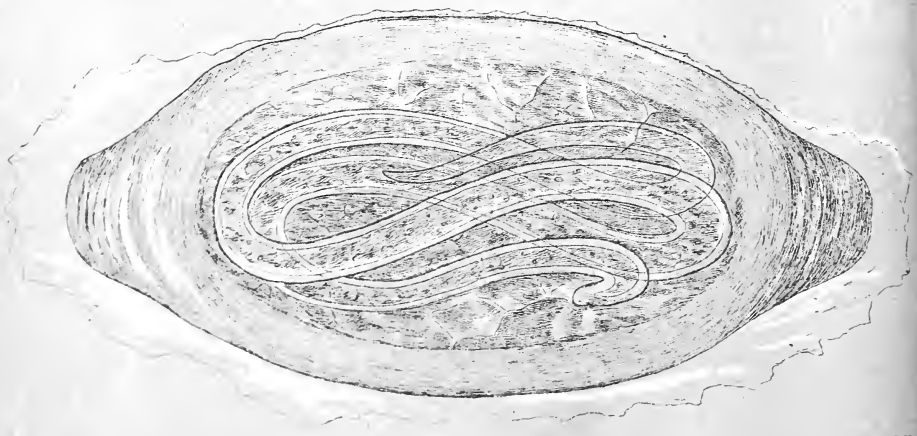
Power of Annelids to reproduce Destroyed Parts.—In Silliman's "American Journal" an article appears from the pen of Mr. W. C. Minor, in which he denies the truth of Dr. Williams's assertion, that "parts removed artificially are never recovered." He has himself seen the head reproduced in Stylaria, Nais, and Dero; and the anal

extreme has also been re-developed in Enchytræus, Lumbricus, Fabricia, and a Nereis, common on our coasts. In the majority of these cases he has seen food taken again, and in all he has seen the *incurrent* anal stream recommence. In one instance he found (August 21) a remnant consisting of five segments of a Nais. It went through a rapid growth; the eyes were developed about the 22nd, and the mouth opened about the 23rd.

The Functions of the Brain and Frontal Ganglion of Insects.—At a late meeting of the "Société Philomathique," a paper was read by M. Ernest Faivre describing the experiments he had undertaken, to ascertain the offices of the above structures. We learn from this communication, which contains the details of several vivisections: 1st, that the brain is the centre from which the direct and reflex impulses proceed; and 2nd, that the frontal ganglion—which is merely an enlargement of the stomato-gastric nerve—is but the conductor of impressions. On irritating the stomato-gastric nerve of a Dyticus behind the ganglion, decided contractions of the pharynx were produced; but when the commissural fibres connecting the ganglion with the brain were divided, these movements were no longer brought about by irritation. When the stomato-gastric was cut at the level of the crop, the latter became distended with gas; but when this section was made in an insect whose fronto-cerebral filaments had been divided, tympanitis was not evident. The only *peculiar* property which the frontal ganglion appears to have, is that of producing movements by *direct excitation* after the commissural fibres have been removed.

The Spontaneous Alteration of Eggs.—The newest and perhaps the most forcible objection to the theory of spontaneous generation, is that embodied in the late contribution of M. Al. Donné to the Académie des Sciences. Having selected a number of hen eggs, M. Donné divided them into two sets: in one, the eggs had the upper end pierced by a small aperture, in the other they were left entire. Both were now exposed for some time to the influence of the atmosphere at a temperature varying from 10° to 36° centigrade, and were then examined. Those which had been opened presented all the signs of putrefaction, mould and organized beings of both kingdoms were present in abundance. The other eggs, however, remained unaffected, and when opened at their extremities, exhibited an empty space (that which in all eggs contains pure atmospheric air); but there was no odorous exhalation, nor was there a trace of any living being, animal or vegetable; but on being exposed for a few days they showed symptoms of putrefaction, and Infusoria and vegetable organisms were detected in them. Thus we see, that here, *although a highly organized and easily decomposable material was exposed to air* (that of the egg), *and to a considerable temperature, no development of organized beings eventuated.* He has also discovered, that if an egg be coated with collodion, so as entirely to prevent the entrance of atmospheric air, and then shaken, so as to destroy its internal physical structure, all the chemical phenomena of decomposition appear; but *not the slightest trace of either animal or vegetable life can be discerned even with the assistance of the microscope.* If these observations of M. Donné be corroborated, they will throw more light on this much debated question than any previous experiment that we are acquainted with, not excepting even that of Schultze.





W.West, Lith.

Parasitic Worm of Muscle.
(Trichina Spiralis.)

DISEASED PORK, AND MICROSCOPIC WORMS IN MAN.

BY JOHN GAMGEE,

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DID Moses know more about pigs than we do? Was it a knowledge of the parasitic diseases common to man and swine which led the father of the Jews to condemn pork as human food? Both questions can be answered in the negative; and the apparently slender grounds on which pigs were first regarded as unclean are stated in the following verse: "And the swine, because it divideth the hoof, yet cheweth not the cud, it is unclean unto you: ye shall not eat of their flesh, nor touch their dead carcase." The wisdom of the Mosaic law can only be justly estimated with a knowledge of the accidents arising in warm countries from eating pork throughout long and hot periods of the year; and there is no doubt that the direct evil results as manifested by human sickness led to the exclusion of pork from the list of Israelitish viands. The masses of measly pork which may be seen hanging from the butchers' stalls in Southern Europe prove that the long-legged swine which hunt the forests for acorns, and rove about to pick up all kinds of offal, are often unfit for human food; and that they were so to no less extent in the land of Israel is probable. There are those who fancy that domesticity breeds disease—that improving the meat-producing powers and hastening the growth of our live stock renders it liable to disorders of a malignant type—no greater fallacy! The parasitic maladies which are bred for man in the systems of the animals we eat are most common in the quadrupeds allowed to rove about in search of food, and which living amongst men and animals, have every opportunity of meeting with the germs of the worms which prey on them. The animalcules which burrow and breed in the human frame are not, as the ancients believed, the results of an agglomeration of *unhealthy humours* becoming vitalized when perfected in form. The advocates of the spontaneous generation theory are now few and far between, and the development of the lower forms of animal life in apparently inaccessible regions of the human

parasite were shown to the Society on the 19th of March, 1853, by Dr. W. T. Gairdner, who, with his usual acuteness, declared that the whole appearance of the parasite was such as seemed strongly to bear out Owen's view, that the trichina was merely the first stage of an animal destined for further development. Dr. Gairdner thought it very probable that the muscle was only the hot-bed of ova, which, for their development into perfect animals, required some other habitat. Considering it to be not unlikely that this further development of trichina might take place in the intestinal canal of some carnivorous animal, Dr. Gairdner sent some of the specimens exhibited, in the fresh state, to Mr. Barlow, who administered portions to dogs and cats;* and I learn from Dr. Mercer Adam that the result of the experiments was as anticipated by Dr. Gairdner. The results were not published, and we owe to continental observers and to Mr. Turner, of the Edinburgh University, interesting information as to the propagation of the parasite.

Professor Owen's first description is in many points complete. In his paper communicated to the Zoological Society of London he says: "With a magnifying power of an inch focus the white specks in the muscle are seen to be cysts of an elliptical figure, with the extremities in general attenuated, elongated, or more opaque than the body (or intermediate part) of the cyst, which is, in general, sufficiently transparent to show that it contains a minute coiled-up worm. On separating the muscular fasciculi, the cysts are found to adhere to the surrounding cellular substance by the whole of their external surface, somewhat laxly at the middle dilated part, but more strongly by means of their elongated extremities, so as to render it generally a matter of some difficulty to detach them. When placed upon the micrometer they measure $\frac{1}{50}$ inch in their longitudinal and $\frac{1}{100}$ inch in their transverse diameter; a few being somewhat larger, and others diminishing in size to about one-half of the above dimensions. They are generally placed in single rows, parallel to the muscular fibres, at distances varying from half a line to a line apart from one another; but sometimes a larger and a smaller cyst are seen attached together by one of their extremities, and they are occasionally observed slightly overlapping each other. If a thin portion of muscle be dried and placed in Canada balsam, between a plate of glass and a plate of talc, the cysts become more transparent, and allow of the contained coiling-up worm being more plainly seen.

"Under a lens of the focus of half an inch, the worm appears

* *The Monthly Journal of Medical Science*, vol. xvi., 1853.

to be inclosed within a circumscribed space of a less elongated and more regular elliptical form than the external cyst, as if within a smaller cyst contained in the larger, like the yolk of an egg surrounded by its albumen and shell. The worm does not occupy more than a third part of the inner space. A few of these cysts have been seen to contain two distinct worms; and Dr. A. Farre, who has paid much attention to the subject, has shown me a drawing which he made of one of the cysts containing three distinct worms, all of nearly equal size.

"The cysts vary in form as well as size, being more or less elongated, and the opaque extremities being further extended in some than in others; in a few instances only one of the extremities is thus produced. Occasionally the tip of one of the extremities is observed to be dilated and transparent, as though a portion of the larger cyst were about to be separated by a process of gemmation."

The coiled parasite is seen in its cyst in the centre figure of the annexed plate, and the peculiarities of the worm are well brought out from the imbibition of an ammoniacal solution of carmine—a method of preparation which often enables us to trace the characters of microscopic objects which are otherwise ill-defined.* The body of the parasite is seen clothed with a transparent skin, which does not imbibe the carmine so readily as the softer structures within. The thickness of the skin has been estimated by Leuckart at 0·001 millimeters. Attention has been drawn by Henle, Luschka, Küchenmeister, and others, to the wrinkled appearance of this skin, which in all perfect specimens is smooth, and not convoluted. Leuckart says that when the parasite is injured, rings round the body are commonly visible. The skin is structureless. Beneath the skin is a layer of a fine granular matter with the appearance of longitudinal stripes and numerous bright refrangent corpuscles. This has been looked upon as the muscular structure of the trichina.

From the cutaneous muscular structure there are two bands, or water tubes, stretched from before backwards on the lateral parts of the body. These are pale, but with well-defined outlines, and stretched alongside of them are small round or oblong yellow corpuscles.

The alimentary canal extends through the whole body from the narrow end or head to the broad anal extremity. The organs of generation do not exist in the encysted worms, and only when they attain their full development in the alimentary

* The specimens from which the two figures of the parasite have been drawn were prepared by Dr. T. R. Fraser, so well known now for his interesting discoveries concerning the action of the Ordeal Bean of Calabar.

canal of their host, though the females are distinguishable from the males even in the capsule.

Without entering into further details as to the worm, it is important to notice the capsule which surrounds it, and which consists of the thickened sarcolemma, and a special envelope for the parasite within this. Leuckart has demonstrated that the trichinæ lead to the removal of the muscular tissue, and are really living in the muscular fibre itself. They are therefore not, as some persons have supposed, in the areolar tissue between the muscular fibres; and the fact of their existence in great numbers, occupying the place of the active muscular element, explains symptoms observed in marked cases of trichinous disease.

From a report in a German veterinary periodical, to the effect that trichinæ could live in roots, and that the domestic quadrupeds derived them from rotten turnips, which abound in trichinæ, I have taken some pains to ascertain if any truth existed in such statements. I find that a species of anguillula preys on the turnip, and is found coiled up in cells much like the trichina; but it is altogether a different parasite; and having fed two pigs on such turnips, I obtained negative results.

At one time it was supposed that trichinæ, as found in the muscles, were the larvæ of a tricocephalus; but the experiments of Virchow, Leuckart, and others, show that the fully developed trichina is a distinct filiform worm, occupying the alimentary canal, and giving birth to young trichinæ, which pierce the walls of the intestine, and on reaching the muscles become capsulated. The appearance of the muscle is well shown by the specimen drawn in the annexed plate; and as the recognition of the disease in the lower animals is the best means to prevent the malady spreading to man, I may now refer to the symptoms manifested by pigs, dogs, cats, rabbits, and other quadrupeds.

The symptoms have been ascertained in the course of experiments, and they are found to vary somewhat in different cases. Not uncommonly rabbits, which are made to swallow thousands of trichinæ, appear to suffer no indisposition for some days, and then die suddenly. Leuckart fed nine rabbits with half an ounce of muscle, containing about 160,000 trichinæ, and repeated the dose about three days afterwards. No symptoms of importance resulted until the seventh day after the first administration, when one of the rabbits died. After death, the diaphragm and the serous coat of the intestine were of an intensely red colour. Exudations had occurred from the mucous membrane, on which numberless trichinæ with their embryos were found. Leuckart and Claus then traced the embryos on the peritoneal coat, having therefore forced through the intestine, and many were also found in the

pleural cavities. None could be traced in the blood of the mesenteric vessels. Leuckart also traced the parasites in the red spots on the peritoneum, which evidently indicate the parts where the parasites were burrowing.

In the pig, thousands of trichinæ may exist without affecting the animal's health; though commonly, at the period of migration from the alimentary canal to the muscular system, there is diarrhœa, lassitude, and a general feverish state. These symptoms may be so severe as to kill, or may pass off; and either the animal lives on with trichinæ in its flesh, which afterwards die and cretify, or within a fortnight or a month there is evidence of pain, stiffness in movements, languor, debility, and death.

What we see in the lower animals has been witnessed in man, and cases are accumulating so as to teach physicians how to diagnose the trichinæ in the living subject.

The early reports of such cases in this country revealed such complications, that the trichinæ have been looked upon as harmless occupants of the muscles of diseased or healthy human beings. The cases reported by Professor Owen belong to this class; and whether the death of the sick people whose histories are given was hastened or not by the trichinous disease, we are left to conjecture. I am inclined to think that the muscular parasite is, to say the least, a dangerous complication, as in the following instance. Dr. Bellingham reports that Bernard Macauley (æt. 67), a labourer, was admitted into St. Vincent's Hospital, December 20, 1851. He had for several years suffered from cough and oppression of his breathing. A fortnight ago, he states that he was attacked with severe pain in the left side after exposure to cold. On examination, signs of bronchitis and emphysema of the lungs were evident; in addition, there was dulness, which indicated much fluid. The breathing was much oppressed, and the patient much debilitated. He gradually became worse, and died on the fifth day after his admission. On examination, the lungs were emphysematous, the bronchial tubes loaded with mucus, the left pleura was coated by lymph, and about a pint and a half of very fetid pus was contained in its cavity. The most remarkable point, however, connected with the case, was the presence of an immense number of the cysts of the *Trichina spiralis* in the voluntary muscles, particularly in the pectoralis major and minor upon each side, in the sterno-mastoid, sterno-thyroid, and omo-hyoid muscles upon both sides. When these muscles were exposed, they had the appearance of being dotted over with innumerable minute white specks of an oval or elliptic form, the long diameter corresponding with that of the muscular fibres; these, on examination, proved to be cysts of the *Trichina spiralis*.

Fatal cases have been reported by Continental observers. Thus, Professor Zenker, of Dresden, mentions that, among 136 post-mortem examinations which he made during eight months of the year 1855, he found four subjects evidently affected with trichina. He gives in detail the case of a farm girl who died under his observation in 1860, killed by trichinæ. She had a month before been taking part with the other farm-servants in a particular pig-sticking, and in the consequent processes, and had probably (according to what is said to be not a very unusual practice) taken an occasional pinch of the sausage-meat which she had to chop. She soon fell ill, and died in five weeks. Her bowels contained swarms of adult trichinæ, and the voluntary muscles throughout her entire body were colonized by myriads of larvæ. It appeared, on inquiry, that other persons who took part in slaughtering the same pig also suffered, and that, though none died, two were bed-ridden for weeks. Microscopical examination of products which were remaining of the slaughtered pig—ham, sausages, and black-puddings—showed in them innumerable dead trichinæ. In July, 1863, a paper was published by Dr. C. Tüngel, of Hamburg, giving particulars of a case in which certainly one death was caused, and perhaps also a second death, as well as some not fatal illness, by the consumption of trichinous pork on board ship. Of the two deaths, one occurred on the 24th, the other on the 27th day after that on which the pig was slaughtered and the consumption of its flesh begun.

In the last number of the *Edinburgh Medical Journal* similar instances are recorded, and, no doubt, ere long science will be enriched by a host of facts which prove that trichinous animal food is a danger to be very carefully avoided.

I have gathered together the facts and observations in this brief article to demonstrate the precise nature of the relation between troublesome, dangerous, and even fatal parasitic diseases of human beings and swine. There are those who consider that we must trust to good cooking to prevent such diseases. I consider it just as reasonable to trust to cleanliness and ventilation to prevent human small-pox. There can be no doubt that care and cleanliness have a tendency materially to diminish the chances of contagion; but as for some wise end, no doubt, contagious diseases present the same determined tendency to reproduction that we notice in the multiplication of parasites, and as our first concern in relation to such maladies as small-pox is to destroy the poison or to combat the virulence of that poison by rendering the human frame but little susceptible to its deadly influences, should we aim primarily at the extermination of the parasites in the animals we eat.

BODILY WORK AND WASTE.

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THERE is no truth which modern science has established with greater certainty than that every manifestation of physical force involves the metamorphosis of a certain quantity of matter; or, to put it in a still simpler form, that every exercise of power is made at the cost of a certain consumption of material. Whether it be the steam which propels our locomotives, or the elastic gases which project our cannon balls, the subtle fluid by means of whose vibrations we convey our thoughts with the rapidity of lightning from one end of the earth to the other, or the still more useful contrivances by which we turn night into day, and maintain the genial warmth of summer amidst the snows of winter — all these exhibitions of force, mechanical, electrical, or thermal, alike involve the disintegration, or, in other words, the *waste*, of some form of matter for their production. Without the combustion of coal or wood there would be no steam for the locomotive, no heat for the fireplace; without a similar, but more rapid, combustion of gunpowder, or other explosive substance, there would be no development of elastic gases in the cannon to propel its ponderous missile; and combustion in these, as in all cases, is essentially a process of waste in which the active part is played by that most energetic of all wasters, the oxygen of the atmosphere. The fluid which circulates in the telegraphic wire is developed at the expense of the acid and the metals of which the batteries at its extremities are composed; and the light which illumines our streets and public buildings is generated by the waste (using the term in its chemical, not, of course, in its economical sense), in gas works, of coal which was produced ages upon ages ago by the submergence and partial decomposition of ancient forests.

Now all these various ways of obtaining power may at first sight appear so very simple in their nature that it may seem trivial to allude to them. Irrespective, however, of the con-

sideration that the simplest phenomena are often those which exhibit in their most intelligible form the grandest and most important laws of nature; and obvious as the fact may seem that the man who attempted to work a steam-engine without supplying coal for its fire would stand but little chance of seeing its wheels revolve, it is doing no injustice to the majority of our readers to suppose that they have never asked themselves what the fuel really does in such a case as this, and why it is so essential to the production of steam? It is probable that the idea may never have suggested itself to them that these, and dozens of other instances of a similar kind which might be quoted, all go to show that without the disintegration, or waste, of some form of matter, whether it be coal, or metal, or tallow, or gunpowder, there is no production of any form of force, no real acquisition of power of any kind. And, like Columbus's egg, simple as this truth may seem when once clearly demonstrated, and often as men have lighted fires to warm themselves by, and long as they have employed the explosive properties of gunpowder to carry conviction to the minds of their *intelligent* fellow-creatures, it is only quite in recent years that its reality has come to be distinctly recognized, and that we have begun to learn that perpetual motion, and other patent processes for extracting something out of nothing, are ideas worthy only of the sages of Laputa.

It may, however, be said, that all exhibitions of force do not involve a waste of matter. We may be told, for instance, that the stream of falling water which turns the river-side mill exerts its power on the mill-wheel in virtue of the force of gravitation which draws the water downwards, and that gravity is a force which, so far as we can see, does not involve the waste of matter as a condition of its manifestation. But this is an exception which is probably more apparent than real, and which is due rather to our ignorance of the nature of gravitation than to any deviation from a law which so unquestionably obtains in the vast majority of phenomena with which we are acquainted. For it is by no means unlikely that gravity, which is itself a cosmical force, acting through space upon the most distant elements of the universe, may be the local manifestation in our world of disturbances in the relations of matter going on in spheres existing at infinite distances from it.

The propulsive force, too, of the breeze by which the ship is driven through the resisting waves, at first sight appears to be a case of force exerted independently of matter or its relations. But here again the exception is only apparent and not real. For science tells us that that breeze is the offspring of

heat acting upon the atmosphere, in which it produces currents; and that the heat comes from the sun, whose material relations exhibit, even to our superficial observation, a state of disturbance which is eminently suggestive of a more profound and incessant disorganization going on beyond our ken.

We may, therefore, take it as unquestionable, that so far as the inorganic forces of nature are concerned, their manifestation in all cases involves the contemporary occurrence of waste, decomposition, or decay. But what are we to say of the forces which are given off by organized bodies? This thinking, talking, acting machine which we call man, whose brain is continually giving off *nerve*-force, which is as constantly stimulating some one or other of his muscles to give off *motor* or mechanical force, and whose whole organism is incessantly maintained by the operations of the *chemical* and *physiological* forces which digest his food, convert it into the various tissues of his body, and again reconvert those tissues into the simpler forms in which, when they have served their part, they are eliminated from the system—hence does he obtain all these forces, or, more properly speaking, all these different varieties of force, which are so indispensable to his existence? Here, too, we must recur for an answer to these questions to the great law of the relations of waste and power to which allusion has before been made. The human body is continually wearing away; as truly, though perhaps not so evidently, burning away as if it were a bushel of coals in a domestic grate. And it is from this ceaseless process of waste which is going on everywhere within it, that it derives the power which it expends in the various forms of work which it continually carries on. There are probably very few of the readers of this article who have the faintest idea of the amount of force which they are exerting every day of their lives. Let us see if we can manage, without wandering into details whose due appreciation would require a knowledge of the more profound departments of physiology, to form an estimate of the amount of work which the body of an ordinary man performs in the twenty-four hours, and of the waste of bodily substance of which that work is the equivalent.

We may roughly divide the constituents of the animal frame into three groups. In the first we will place those substances which are actually incorporated into its organization in the shape of bone, muscle, nerve, &c.; to the second we may assign those which are destined to minister to the building up of the animal fabric, in the shape of the raw materials derived from the digestion of the food in the alimentary canal, and, in the third, we shall place those constituents which, having discharged their functions in the animal economy as

elements of the various tissues, are thrown off as waste, and as such give rise to what are commonly known as the excretions of the body. It is obviously to this last class that we must look for the measure of the wear and tear of the body and of the evolution of force of which that wear and tear is the exponent.

Now, of all the different substances which are thus thrown off from the body as the result of the decay which is continually going on within it, there is one, urea, which is pre-eminently important, not from its mere predominance in bulk over all the others, but because it is the one which gives us the most accurate gauge of the amount of waste of which it is the product.

If we were to be told that the quantity of urea which is daily manufactured and eliminated from the body of a healthy man, weighing about 150 lb., varies from 400 to 630 grains, it is probable that many of us would not be much the wiser for the information. We must, therefore, see if we can learn what this represents in another way.

The daily work which is performed by the body of an ordinary human being may be classed under four heads. (1) There is the *vital* work, or that which is required to keep the machinery of life going and in proper order; *e. g.*, to make the heart beat, the stomach digest, the liver secrete bile, and so on; just as a certain portion of the power of a steam-engine is expended in merely moving the machinery which it sets in action. (2) Then there is what may be called the *calorific work*, or that which is required to maintain the temperature of the body, and which will obviously be much greater in winter than in summer, and in cold climates than in warm ones. Although this is intimately connected with the preceding variety of work, still it is for many purposes sufficiently distinct and important to justify our considering it under a separate head. (3) Next we have the *mechanical work* which is involved in the physical exercise we take, such as walking, talking, eating, &c. (4) And, lastly, there is the *mental work*, which we each of us perform in the acts of thinking, seeing, hearing, and in the exercise of our nervous functions generally. One of the great problems which physiology has of late been endeavouring to solve is, how much of the total daily work of the body is absorbed by each of these four departments of bodily activity separately; or, to put the question in another point of view, how much of the total daily waste of the body is due to them severally? The recent researches* of a distinguished medical divine—for, by a strange coincidence, though a clergyman by profession he is also a physician by education (the Rev. Pro-

* *Dublin Quarterly Journal of Medicine*, 1859, 1860.

fessor Haughton, M.D., F.R.S., of Trinity College, Dublin)—have thrown a good deal of light upon this obscure and difficult subject. With the view of giving our readers a general idea of the relations of bodily work to bodily waste, we will briefly recapitulate the nature of these researches.

We have before stated that the total amount of urea which is formed in the body of a healthy man of 150 lb. weight, *per diem*, fluctuates from 400 to 630 grains. Of this amount Dr. Haughton calculates, from data to which it is impossible for us here to refer, that 300 grains are the result of that division of work to which we have above given the designation *vital*. Hence it follows that each pound of man requires an amount of daily waste which is represented by 2 grains of urea merely to keep it alive, and prevent it from becoming subject to the ordinary chemical laws of inert matter.

But if this 300 grains of urea represents a certain amount of bodily waste, that bodily waste in its turn represents a certain amount of work done, or force expended; and to estimate what that work is, we must find out the equivalent, in some definite and easily calculable form of work, of a definite quantity, say one grain of urea. This Dr. Haughton has done. But before stating the results at which he has arrived on this point, it should, perhaps, be mentioned, for the benefit of those to whom this subject may be entirely new, that it is usual to calculate all varieties of mechanical force in terms of a single unit, and that unit is the force which is required to raise one ton avoirdupoise one foot from the earth. For instance, a man who walks twenty miles a day can be shown in so doing to perform an amount of mechanical work which, if applied in another way, would raise a weight of 150 lb., *i. e.*, about the weight of his own body, one mile in the air. Again, the ordinary daily work of a street paviour, who works ten hours a day, and whose occupation consists in lifting, at definite intervals, a rammer weighing 5½ stone, is equivalent, if applied as before mentioned, to lifting a weight of one ton 352 feet in the air. In this way the foot-ton, as it is called—*i.e.*, one ton lifted one foot—becomes the unit of measurement of dynamical force generally.

Now, let us recur to the consideration of the force which is expended in the daily waste of 300 grains of urea. From a series of elaborate calculations Dr. Haughton estimates that the mechanical equivalent of this quantity of urea is one ton lifted 769 feet, or 769 foot-tons. That is to say, this enormous force—a force which is more than equal to that expended by two street paviours during a hard day's work, is used up in merely keeping a man of 150 lb. weight alive for the same period. We may put the same fact in another point

of view by saying that the amount of force required for this purpose would lift the man's body a little more than two (2·18) miles in the air during the twenty-four hours.

From similar, though perhaps somewhat more doubtful calculations, Dr. Haughton estimates that the amount of bodily waste which is caused by one hour's hard mental labour involves an expenditure of force which is equal to lifting 111 tons one foot in the air.

Let us further suppose that, in addition to the mere act of living, an average man of 150 lb. weight undergoes bodily labour equivalent to lifting 200 tons one foot daily, and that the total amount of his day's mental work is equivalent to two hours' hard study, and the "little bill" of his daily expenditure of force will stand as follows :—

Vital work	300·00	grains of urea	= 769	foot-tons
Bodily work	77·38	„ „	= 200	„
Mental work.....	86·00	„ „	= 222	„
Total urea	463·38	=	1191	tons raised one foot ;

or one ton raised 1191 feet ; or the weight of the man's body (150 lb.) raised a little more than 3 miles.

To balance this side of his debtor and creditor account, our average man would have to consume an amount of food sufficient to furnish him with the nitrogen contained in 463 grains of urea. Hence he will find it desirable to take a considerable portion of animal food in his diet, because that kind of food contains, in proportion to its bulk, a much larger quantity of nitrogen than vegetable substances do ; for if he does not do this, he will have to augment the amount of vegetable material which he ingests to such an extent as seriously to embarrass his digestive functions. It is for this reason that the labouring man, who cannot procure meat for his daily meal, has recourse to cheese, which, although difficult of digestion, contains a considerable quantity of nitrogen.

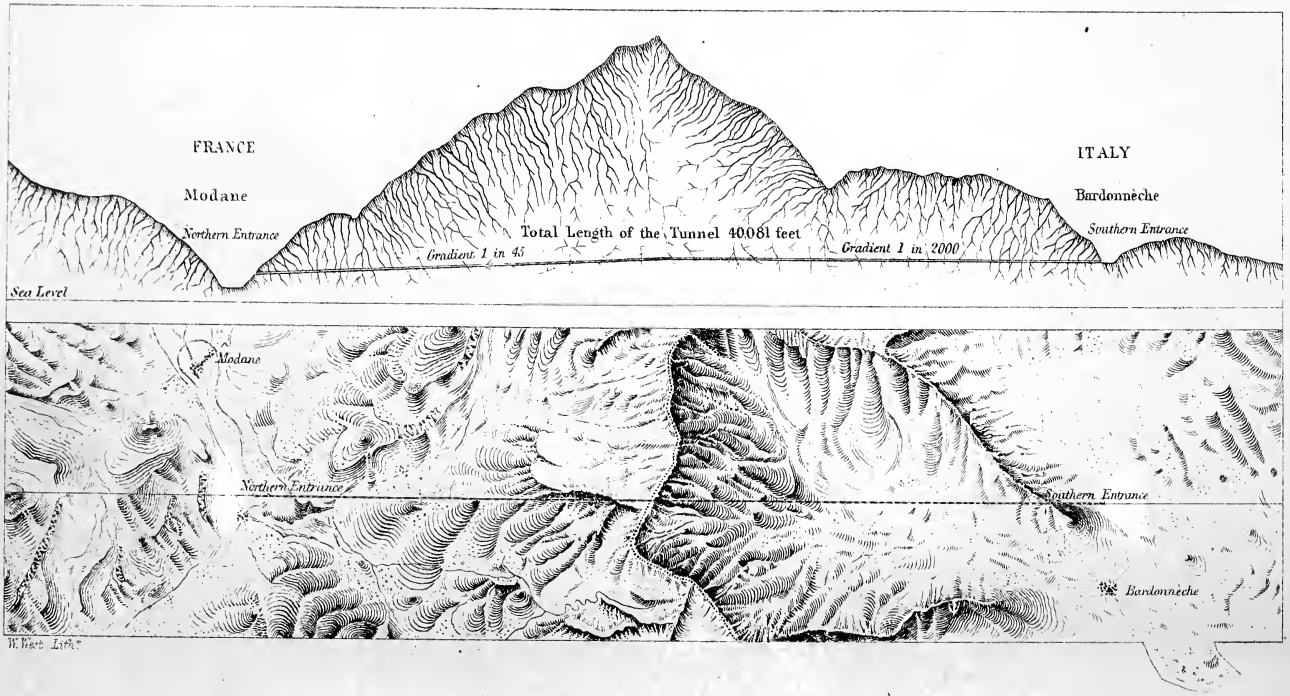
But, the reader may not improbably ask, if all this enormous quantity of force is expended by a living man during the short space of twenty-four hours, whence does it all come ? And this is a question which it is by no means easy to answer clearly within the limited space which is left to us. In general terms, however, it may be said that the force which the animal economy expends in the discharge of its various functions, is intimately incorporated with the food which it ingests for the support of its material framework. Animals live at the expense either of other animals or of vegetables—in both cases of previously organized structures. Every process of organization involves the absorption and fixation of force in the created

organism. Hence every organized structure is, as it were, a reservoir of force. The force which the plant receives from the solar heat is stored up in its cells, to be dispersed again gradually to the atmosphere in the shape of heat when it decays, or rapidly, when it burns as coal; or, if consumed by an animal as food, is incorporated, with the elements of the plant, into the tissues of the animal which consumes it. These animal tissues thus become storehouses of power, which, as they waste and decay, is given off in the various forms which their peculiar character adapts them to eliminate. Thus the nervous tissues give it off as nerve-force; the muscles, as motor force; the fatty elements of the body, as heat; and so on. One of the most interesting branches of Dr. Haughton's researches is the determination of the amount of force which is stored up in human muscles.* By a series of careful observations and calculations, he finds that the muscles which sustain the arm in a horizontal position—the central portion of the deltoid and the supraspinatus—weigh $5\frac{1}{8}$ ounces, or $2{,}242\frac{1}{2}$ grains, and that the work which they do in sustaining the arm until it becomes exhausted is equivalent to lifting half a ton through one foot. Hence it follows, that 1 lb. of such muscle contains, stored up in it, sufficient force to raise 1·56 ton through the same distance. This statement will go far to explain the origin of a portion, at least, of the force which is expended daily by the body of a living man. When it is remembered that during his waking hours the voluntary muscles of man are rarely at rest for more than a few seconds together, it will be seen that we have, in their constant waste alone, a fertile source for the evolution of force. But it is to the action of the involuntary muscles that we must look for the most abundant origin of the force which he is ceaselessly eliminating, and more especially to that most important of all the involuntary muscles, the heart, which, from the time he draws his first breath till his eyelids close in death, is never at rest. Most persons are aware that the heart is simply a muscular bag, divided into four cavities, and that the circulation of the blood through the blood-vessels, which is so essential to the maintenance of life, is mainly due to the force with which the muscular walls of the heart contract on the blood as it passes through these cavities. Few, however, would imagine the force which this small fleshy bag—no larger than one's double fist, and only weighing about nine ounces—exerts on the mass of blood which it is called on to propel. Dr. Haughton has most ingeniously estimated that the force which the heart expends in the twenty-four hours is equivalent to lifting 124 tons one

* "Outlines of a New Theory of Muscular Action," 1863.

foot! This estimate would be almost incredible, if it were not obtained by two totally different methods of calculation, used as checks upon one another. And if this amount of force is expended by the heart in twenty-four hours, how rapid must be its waste, and how vigorous must be the nutrition by which that waste is repaired. Few instances could be quoted which show more forcibly than this does the wonderful perfection of adaptation, and the concentration of activity which the higher organized structures exhibit.

To those who are not familiar with the subject of physiological dynamics these statements, generally, will probably appear little short of incredible, so difficult is it for the imagination which is untrained in the teachings of science to realise the fact, that the apparently simple and unlaborious functions of mind or body can involve the expenditure of force at all. The most unscientific observer cannot fail to perceive that the arm which works the paviour's rammer, or the legs which bear the weight of the body over the many miles of a long day's walk, must, in the performance of these offices, exert a considerable amount of force; but he does not so readily appreciate the manifestation of the same phenomenon in the silent decay of the whole body when at rest, or in the unconscious exercise of the mind. Those, on the other hand, who have learned with what a mighty energy nature works even in her most simple operations—that the force which holds the elements of a single grain of water together is equal to that which is contained in a very powerful flash of lightning, will know that, although there are some of Dr. Haughton's calculations which, from the uncertain state of our knowledge, must at present be received with some degree of reservation, the general character of his results is quite in unison with the dynamical laws which the researches of Joule, Mayer, and other physicists have during recent years established.



RAILWAY TUNNEL THROUGH MONT CENIS FROM BARDONNÈCHE TO MODANE.

Longitudinal Section and Plan

The vertical Scale of the Section is double the Horizontal Scale.

THE RAILWAY TUNNEL THROUGH THE ALPS.

THERE is at present a break in the railway system of communication between France and Italy, occasioned by no less an obstruction than the Alps. To pierce a passage through the Alps, and complete the line of communication between the opposite sides, is the object of the tunnel now in course of execution. This gigantic work, which will be, when completed, fully seven and a half miles in length, was sanctioned by the Sardinian Government in 1857, and although, in June, 1858, and September, 1859, arrangements were made for fixing perforating machinery, the work was not actually commenced till November, 1860. The railway from Genoa and Turin stops at Susa, and that from Lyons at St. Michael; between these two termini, Mont Cenis intervenes. The northern entrance of the tunnel (A) is near the little hamlet of Fourneau, and less than half a mile from the small town of Modane. The southern end is in a deep valley at Bardonnèche, on the Italian side of the Alps.

The entrance to the tunnel on the side of France is 3,946 feet above the level of the sea, and its termination on the Italian side 4,380 feet; so that the actual difference of level between the two extremities of the tunnel is about 434 feet, the Italian end being thus much the highest. There are two gradients in the tunnel, which divide it nearly in two equal lengths, the ascending gradient from the side of France rising to 445 feet, from which point it gradually falls to the opposite end, on the side of Italy, to the amount of only about 10 English feet, in a length of nearly $3\frac{3}{4}$ miles; so that for this distance it may be considered to be practically level.

The rising gradient ascends to the middle of the tunnel at the rate of 1 in 45. The descending one falls at the rate of 1 in 2,000; so that one half of the tunnel has a tolerably stiff gradient, and the other quite easy; but for such an Alpine country the gradient of 1 in 45 is much better than might have been expected under the circumstances.

It was, of course, necessary to prepare accurate plans and sections to determine the levels, fix the axis of the tunnel, and set it out on the mountain top; to erect observatories and guiding signals, solid, substantial, and true. The mountains

had to be surveyed and triangulated, bases measured, and the exact length and levels of the tunnel determined with the greatest care and accuracy; for errors in the angles and reduced calculations would have led to the most disastrous consequences in a tunnel of this enormous length. The difficulty of tracing the axis, and setting out a corresponding line over the summit of an Alpine range, over rocks, ravines, and precipices; of continually climbing, ascending, and descending the immense heights, from point to point and from station to station, may be readily appreciated by those accustomed to ramble among lofty mountain ranges.

Great as the labour and difficulty of climbing and scaling these rugged heights may have been, they were as nothing compared to the engineering difficulties created by the inclemencies of the weather. These were the greatest stumbling-blocks of all, from the impossibility of continuous work with levels and theodolites in such a wild and exposed place. The engineers were exposed to all the tempests common to these Alpine regions—rain, mist, sleet, drifting snow, and their more troublesome and ever-constant enemy, the howling wind, ever constant in its wild and fierce inconstancy. It was impossible to work with delicate instruments when exposed to storms and hurricanes at these lofty elevations; hence, it frequently happened for days together that not a single observation or an angle could be taken. However, after a long, laborious, and patient work, this all-important and interesting triangulation, with all its troublesome details, was brought to a happy issue and triumphant conclusion; and the final direction and exact length of the axis of the tunnel accurately determined.

The total length of the tunnel was determined to be 12,220 metres, or about 7 miles, 4 furlongs, and 164 yards; and, notwithstanding all the difficulties of the various operations and ceaseless hindrances, in spite of Alpine seasons, so accurately was the triangulation executed, that the maximum deviation from exactitude was confined within the limit of 11·417 inches in the whole distance of $7\frac{1}{2}$ miles, or about $1\frac{1}{2}$ inch per mile, which, of course, can have no practical effect in a work of this magnitude.

The mountain through which the tunnel is to be pierced is exceedingly rough and irregular in outline, and, as might have been expected, very steep and rugged. The lowest point is at Fourneau, close by the main route over Mont Cenis. From this valley, which is at an elevation of about 3,600 feet above the level of the sea, the mountain ascends rapidly 348 feet to the northern entrance to the tunnel, which is in a picturesque gorge in the valley. It then rises rapidly 1,140 feet more, to Les Aysards, a cluster of chalets in the slope of the mountain, where is placed the first signal station. The line then runs

along the rugged slopes, and rises a further height of 334 feet, immediately after which it drops down to the ravine in which rushes the Torrente del Grau Vallon. After crossing the impetuous stream, it rapidly ascends a height of 2,430 feet, till it reaches the station La Riond with a further ascent of 725 feet. From this latter point it skirts the shattered slopes of a steep precipice to the Vallonet station with a rise of 1,004 feet. The line then crosses the apex of the rocks, and at once rises precipitously up to the observatory on the pinnacle-like summit with a further rise of 246 feet, this summit being 9,675 feet above the level of the sea, and 5,714 feet above the tunnel mouth at Fourneau. From this point the mountain descends with great rapidity over exceedingly rugged and broken ground, no less than 3,588 feet at one swoop, to the torrent of the Merdovine, which flows down a deep valley. It once more rises 380 feet, passing a wild and broken country, to the apex of a precipice at the Banda station, from which it again falls with a rapid drop of 1,500 feet to the southern mouth of the tunnel at Bardonnèche, close to the torrent of the Rochemolles.

The heights of some of the Alpine peaks in the immediate neighbourhood of the course of the axis of the tunnel reach the following elevations, expressed in English feet :—

Mont Rond	8,057	Bellcoll	7,886
Mont Pelouse	10,384	Chabriere	7,358
Punta di Frejus ...	9,761		

So that the summit of the highest Alp, Mont Pelouse, near the line of tunnel, is 10,393 feet above the level of the sea, being thus considerably above the limit of perpetual snow, and nearly twice the height of the great road over Mont Cenis.

The preparatory works were of vast magnitude, including the construction of new and solid roads, of vaulted canals, bridges, magazines, offices, workshops, forges, furnaces, and machinery, driven by a turbine of 12-horse power; extensive reservoirs,—some underground, to shelter them from the frost, high up on the mountain side; residences for the men, offices for engineers; being, in fact, a complete and perfect establishment of great extent and variety, both at Bardonnèche, Modane, and Fourneau.

As the excavation of the tunnel was not to be effected by manual labour, nor indeed by steam, other means had to be adopted, and new machinery devised for the purpose. The power of water, so plentifully supplied by the Alpine snow and rain, was the great motive power determined upon, as being the most economical and manageable for such a mountainous locality; hence, new hydraulic and pneumatic machinery had to be invented, tested, varied and improved. Water was the

generating power, but the perforating machinery was to be driven by the action of compressed air, the *modus operandi* of which had to be determined and put to the test of actual work and experiment on a grand scale before the real labour of the excavation began.

Besides driving the perforating tools, the same air had to ventilate the tunnel, and keep it in a fit state for respiration; for it will be seen that a tunnel without shafts, more than 7½ miles long, could not be ventilated by the ordinary method usually employed for such purposes.

Passengers traversing Mont Cenis pass through the little Alpine town of Modane, where there are numerous works connected with the tunnel; and also the hamlet of Fourneau, where again are seen extensive establishments of an appearance and character little dreamt of by travellers in a wild and romantic pass like this. The mass of pipes and tubes for air and water look quite bewildering, looming like the apparatus of some Titanic distillery. It seems incredible to the passing stranger that this pile of pipes, tubes, tanks, and reservoirs, are employed for the purpose of boring into the bowels of an Alpine mountain of hard and solid rock without the aid of steam, and little help from manual labour.

A novel machine for perforating hard rock was not easily brought to perfection; it required a long and elaborate series of practical working experiments, and numerous modifications in detail, before being considered fit for the real work it had to do. It required to be of sufficient power to do the work with ease and precision, of such size and weight as to be easily managed by one or two men, and so strong and simple in form and construction as to avoid the necessity of frequent stoppage and repair; for the work such a machine was required to do should be continuous night and day as far as possible.

It appears from the report of the engineers, that the time the machines were actually at work, during the year 1861, at Bardonnèche, was only two hundred and nine clear days, with an actual advance of the whole front of the excavation of 559 feet, which only gives a daily progress of about 2 feet 8 inches. At the same place, during 1862, there appears to have been three hundred and twenty-five full working days, with an actual advance of the tunnel of 1,216 feet, which gives for the daily working progress of the complete tunnel about 4 feet 5 inches. At the northern end of the tunnel of Modane, for the same year, 1862, the advance is stated to have been at the rate of nearly 40 inches per diem.

Since 1,216 feet were actually advanced in three hundred and twenty-five days at Bardonnèche, this will give for the entire year, if in full operation at the same rate, an advance of

1,515 feet, and if we add the 1,197 feet for the progress at Modane during the same period, the total progress forward at both ends for an entire year will be 2,712 feet; so that at this rate of working, it will require $14\frac{3}{4}$ years to complete the excavation: and taking all the circumstances of the case into consideration, it is doubtful if the tunnel can be bored through in a less period of time.

The total estimated quantity of rock to be excavated is about 784,666 cubic yards. As the tunnel is 13,354 yards long, this will give for the lineal yard forward, and for the whole face of the tunnel to be removed, nearly 58 cubic yards. At the average advance of 4 feet 5 inches per day, as above stated, this will give a daily removal of $73\frac{1}{2}$ yards cube; and if both faces are worked at the same progressive rate, it will yield 147 cubic yards of daily excavation for the joint work of all the boring machines in operation. This supposes continuous working, which, however, is scarcely possible, for there is always time required to charge the bore holes, fire the blast, break down shattered rock, and remove the whole of the loosened material out of the tunnel.

There will also be a sensible loss of time occasioned by prolonging the pipes and tubes for the compressed air to work the machines, for the water and gas pipes; for all these must keep pace with and follow up the advance of the perforating machines in the tunnel, as well as the timbers and rails for carrying the machines, and other indispensable work of the kind, all of which must advance simultaneously.

The rock in which the excavation is at present being made is of a quality exceedingly difficult to work, having what the engineers have called an "infelicitous stratification," with great diversity of texture, which has proved very trying to the perforators. The rock is a crystallised calcareous schist, very much broken and contorted; being interspersed in almost every direction with large masses of pure quartz, in veins of variable dimensions, straggling irregularly through the general body of the rock.

It has proved difficult to work in a diversified material of this character from the unequal resistance presented to the perforators by the calcareous schist and quartz, it not unfrequently happening that the chisels have to be turned from their proper direction, through meeting with a block of quartz, which, of course, leads to loss of time.

The production of compressed air at Bardonnèche, for the year 1862, amounted to 152,100 cubic yards per month, with an actual pressure of 90 lb. per square inch; the entire year giving the immense amount of 1,825,000 cubic yards; which is equivalent to a volume of air at its ordinary pressure of 11,024,000 cubic yards. It was ascertained by experiment that

each perforator, working at its ordinary rate, consumed about 190 cubic inches of compressed air per second, so that the nine machines expended nearly one cubic foot per second, or about 3,425 cubic feet, English, of air, compressed to a pressure of six atmospheres, or, in round numbers, with a working force of 90 lb. per square inch of surface. When the air, so compressed to six atmospheres, is liberated in the tunnel, and expands to its normal state of pressure, it is found to absorb nearly the same quantity of heat which it gave out in the act of compression. By this absorption of heat from the air in the tunnel, the temperature, which has been raised by the workmen, the lamps, and gas is considerably lowered, thus rendering it more cool, fresh, and suitable for respiration.

At Bardonnèche, during the 325 useful working days, the number of holes bored to a depth from 30 to 32 inches amounted to the number of 45,751; the number of chisels employed was 72,538; the gunpowder consumed weighed 40,735 lb.; and the length of match for firing the mines amounted to 251,000 feet. In 1861 the machines advanced the tunnel 557 feet, by boring 20,000 holes; in 1862 they bored 46,000, besides 6,000 made during the working experiments; amounting altogether to 72,000 holes, divided amongst 80 perforators; from this it results as a mean, that 900 holes were drilled by each of the perforators. The eight machines worked ten perforators, and made 80 holes in 7 hours 39 minutes, so that each machine took 7 hours 39 minutes to bore 10 holes, or three-quarters of an hour for each mine hole. In three-quarters of an hour each machine worked at the rate of three blows per second, making 8,100 evolutions complete, thus giving 8,100 blows of the chisel to execute one hole. The 900 holes bored on an average, as above stated, gives for each perforator $8{,}100 \times 900 = 7{,}290{,}000$ blows, worked by air.

By way of comparison of cost, it may be observed that the Bletchingly tunnel on the South-Eastern Railway, in blue clay, shale, and sand, cost at the rate of £71. 18s. 7d. per yard forward; the Saltwood tunnel, on the same line, £118; the Kilsby tunnel, on the London and Birmingham, £125; and the Clay Cross, on the Midland Railway, £100 per yard forward. The estimated cost of the Mont Cenis tunnel is stated to be at about the rate £166 per lineal yard. Assuming this to be near the mark, the entire tunnel will cost, at this rate, upwards of two millions sterling. One item of cost in this tunnel, which must not be overlooked, is the heavy amount of transport, the length from the middle of the tunnel to either mouth being upwards of three miles and a half. The tunnel is for a double line of rails.

The wear and tear of the perforating machinery has been found greater than was expected; for the hard, sharp-cutting

particles of dust from the drilled quartz and other rocks causes constant and considerable damage to the machines. This will be readily imagined when the number of blows, pushes, and revolutions made by the boring tools are enumerated. To bore eight holes $2\frac{3}{4}$ feet deep in the rock, when of average working quality, the motory cylinder completes 57,600 revolutions; the striker, or driving piston, 57,600 blows; and the chisels make the same number of turns or twists.

As a matter of mere curiosity, to show the magnitude and extent of the various operations to be performed and labour required, it may be stated that if the above rates of working should be maintained, the number of holes necessary to be bored to get through the whole tunnel will amount to about 1,600,000. The total depth of all these holes, when bored, will amount to about 4,265,890 feet, which is 105 times longer than the entire length of tunnel to be excavated. The number of blows required to be struck by the perforators to do this work will reach nearly 13,000,000,000.

It may be explained briefly, that the tunnel, for its whole width of face is not attacked at once, a "gullet" or heading is driven considerably in advance of the completed work. This small gallery is rather more than 11 feet wide, and $7\frac{3}{4}$ feet high, and square in form. A line of rails is laid nearly the whole length of this gallery, of usual gauge, to communicate with the line in the main tunnel; beside this, there is a line of rails of lesser gauge for the small trollies, used to convey the broken rocks from the head of the gallery to the common trucks. In general the machines which attack the front of this heading are armed with nine or ten perforators—some acting directly in the face, others diverging to the right and left, and thus carry on the borings in the gullet, till all the holes are ready for their charge of powder. Thirty-seven men and boys are required to attend to the machines, and other matters in connection with them.

The work of the main tunnel follows up the small gallery, which is progressively widened to the extent and form required for the full section of the complete excavation. It has been estimated from data obtained by actual working of the machines, that the tunnel may possibly be excavated in fifteen years; but it appears that twenty years is the time calculated upon by the engineers engaged in the conduct of the work. The limit assigned for the completion of the tunnel in the convention agreed between the French and Italian Governments, is twenty-five years. It is, however, a work requiring time, money, and patience; it cannot be hurried, and must look to completion from steady and unremitting labour day and night, without ceasing.

GREEK FIRE: ITS ANCIENT AND MODERN HISTORY.

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WHAT is Greek Fire? The question is not one of to-day, but of ages. Friar Bacon was asked the question, or, at all events, he, in a sentence or two as difficult to understand as obscurest alchemist could wish, essayed to answer it. His friend, Friar Bungay, who was neither so imaginary a man nor so gross a quack as Sir Edward Bulwer Lytton has depicted him, and who, in his day, did many marvels, made a guess at it; the Princess Anna Comnena supplied a formula for it; Charles du Fresne, the Byzantine historian, cultivated many and curious researches in respect to it; Sir William Temple took it under his literary protection, and gave its introduction to the world, within a century; the historical commentators on the History of St. Louis—Ducange and Joinville—were each particular in their inquiries and descriptions; Gibbon, as we shall see, was careful, to a nicety, to dig out every fact; Chambers advanced at least three speculations on it; the learned Beckman of course looked and looked, and said all he could, which was not much but good; and, in fine, from the thirteenth century to this, the nineteenth, somebody has always been speculating and nobody has been satisfied.

At last, when the Dryasdust fraternity were getting into that state of obscurity as to affirm, with all profundity and good faith, that there never was such a thing as Greek fire, that the whole story was a myth of the middle ages, that Greek fire ranked with flexible glass and the elixir vitæ,—General Gilmore, Federal general before Charleston, in Southern America, startled the learned by pitching a shell of so-called Greek fire a distance of four miles at least, and into a town. What is Greek fire? At once the question went up again, and everybody asked everybody, and everybody, or nearly so, said they did not know; or made a guess like the Princess Anna Comnena, or divined obscurely, like Roger Bacon, as if they did know, but did not like to tell. And still the question is on the *tapis*. Let us try to answer it.

ANCIENT GREEK FIRE.

Regarding the ancient Greek fire, the facts that have been collected about it are at present to be sought for, mainly, from the various authors whose names have been given above.

Gibbon, in describing the destruction of the Saracen fleet in the harbour of Constantinople, in his tenth volume of the "Rise and Fall," gives a graphic account of the ancient Greek fire. He says:—

In the two sieges, the delivery of Constantinople may be ascribed to the novelty, the terrors, and the real efficacy of the Greek fire. The important secret of compounding and directing this artificial flame was imparted by Callinicus, a native of Heliopolis, in Syria, who deserted from the service of the Caliph to that of the Emperor. The skill of a chemist and engineer was equivalent to the succour of fleets and armies; and this discovery or improvement of the military art was fortunately reserved for the distressful period, when the degenerate Romans of the East were incapable of contending with the warlike enthusiasm and youthful vigour of the Saracens. The historian who presumes to analyse this extraordinary composition should suspect his own ignorance or that of his Byzantine guides, so prone to the marvellous, so careless and, in this instance, so jealous of truth. From their obscure and perhaps fallacious hints, it would seem that the principal ingredient of the Greek fire was the naphtha or liquid bitumen, a light, tenacious, and inflammable oil, which springs from the earth and catches fire as soon as it comes in contact with the air. The naphtha was mingled, I know not by what methods, or in what proportions, with sulphur and with the pitch that is extracted from evergreen firs. From this mixture, which produced a thick smoke and a loud explosion, proceeded a fierce and obstinate flame, which not only rose in perpendicular ascent, but likewise burnt with equal vehemence in descent or lateral progress; instead of being extinguished, it was nourished and quickened by the element of water; and sand, urine, or vinegar were the only remedies that could damp the fury of this powerful agent, which was justly denominated by the Greeks, the liquid or maritime fire. For the annoyance of the enemy, it was employed with equal effect, by sea and land, in battles and in sieges. It was either poured from the rampart in large boilers, or launched in red-hot balls of stone and iron, or darted in arrows and javelins, twisted round with flax and tow, which had deeply imbibed the inflammable oil; sometimes it was deposited in fire-ships, the victims and instruments of a more ample revenge, and it was most commonly blown through long tubes of copper which were planted on the prow of a galley, and fancifully shaped into the mouths of savage monsters that seemed to vomit a stream of liquid and consuming fire. This important art was preserved at Constantinople as the palladium of the State: the galleys and artillery might occasionally be lent to the allies of Rome; but the composition of the Greek fire was concealed with the most zealous scruple, and the terror of the enemy was increased and prolonged by their ignorance and surprise. In the treatise on the Administration of the Empire, the royal author

(Constantine) suggests the answers that might best elude the indiscreet curiosity and importunate demands of the Barbarians. They should be told that the mystery of the Greek fire had been revealed by an angel to the first and greatest of the Constantines, with the sacred injunction that this gift of Heaven, this peculiar blessing of the Romans, should never be communicated to any foreign nation; that the prince and subject were alike bound to religious silence under the temporal and spiritual penalties of treason and sacrilege; and that the infamous attempt would provoke the sudden and supernatural vengeance of the God of the Christians. By these precautions the secret was confined, above four hundred years, to the Romans of the East; and at the end of the eleventh century, the Pisans, to whom every sea and every art were familiar, suffered the effects without understanding the composition of the Greek fire. It was at length either discovered or stolen by the Mahometans; and in the holy wars of Syria and Egypt they retorted an invention, contrived against themselves, on the heads of the Christians. A knight, who despised the swords and lances of the Saracens, relates with heartfelt sincerity his own fears and those of his companions at the sight and sound of this mischievous engine that discharged a torrent of the Greek fire, the "feu Gregeois," as it is styled by the more early of the French writers. It came flying through the air, says Joinville (History of St. Louis), like a winged long-tailed dragon, about the thickness of an hogshead, with the report of thunder and the velocity of lightning; and the darkness of the night was dispelled by this deadly illumination. The use of the Greek, or, as it may be called, the Saracen fire was continued to the middle of the fourteenth century, when the scientific or casual compound of nitre, sulphur, and charcoal effected a new revolution in the art of war and the history of mankind.

From certain allusions as to the manner in which the Greek fire was used—viz., that it was cast from catapults and slings—I was inclined at one time to believe that a solid ball was cast from the engine, and that it ignited in its course through the air. On further inquiry I feel that this hypothesis is untenable, the arguments of Beckman appearing to be conclusive that the substance employed was liquid, and was even sometimes thrown from engines constructed after the manner of our modern fire-engines. He remarks that, in the East, engines were employed not only to extinguish but to produce fires:—

The Greek fire invented by Callinicus, an architect of Heliopolis, a city afterwards named Balbec, in the year 678, the use of which was continued in the East till 1291, and which was certainly liquid, was employed in many different ways, but chiefly on board ship; being thrown by large fire-engines on the ships of the enemy. Sometimes this fire was kindled in particular vessels, which might be called fire-ships, and which were introduced amongst a hostile fleet; sometimes it was put into jars and other vessels, which were thrown at the enemy by means of projectile machines; and sometimes it was squirted by the soldiers from hand engines, or, as it appears, was blown through pipes. But the machines with which this fire was dis-

charged from the fore part of ships could not have been either hand engines or such blow-pipes. They were constructed of copper and iron, and the extremity of them sometimes resembled the open mouth and jaws of a lion or other animal; they were painted, and even gilded, and it appears that they were capable of projecting the fire to a great distance.

In some of the ancient drawings of ships, we see as a figure-head an animal with rays issuing from the mouth, as if fire were being vomited forth—a representation, probably, of the ancient fire-ship described above. Even in the present day the same kind of figure-head is sometimes erected.

Continuing his narrative, Beckman states that the machines by which the liquid substance was thrown forth were expressly called, by the ancient writers, spouting engines.

John Comeniata, speaking of the siege of his native city, Thessalonica, which was taken by the Saracens in the year 904, says that the enemy threw fire into the wooden works of the besieged, which was blown into them by means of tubes, and thrown from other vessels. This passage which I do not find quoted in any of the works that treat of Greek fire, proves that the Greeks, at the beginning of the tenth century, were no longer the only people acquainted with the art of preparing this fire, the precursor of our gunpowder. The Emperor Leo, who about the same time wrote his "Art of War," recommends such engines, with a metal covering, to be constructed in the fore part of ships; and he twice afterwards mentions engines for throwing out Greek fire.

Great attention has been paid to the question,—At what period was the Greek fire introduced into warfare? Sir William Temple traced it as far back as the seventh century, but Gibbon treats the argument as destitute of fact, and, indeed, as false. Theophanes, however, and Cedrenus, trace it back to the year 660, when, they say, it was discovered by the engineer Callinicus, of Heliopolis, or Balbec, who, it is reported, learned the art of chemistry from the Egyptians, the fathers of the art. Nay, by others the discovery has been traced back to the pure Greek and Roman period, the invention being assigned, by Joseph Scaliger, to one Marcus Gracchus, or Græcus, and its application being declared as connected with the wars between the Greeks and Romans, and as common to both sides. Respecting this last-named hypothesis, I have only to state, that no direct testimony for its support is to be found. The assertion is made purely on inferences drawn from the Greek and Roman writers. By the same process of reasoning I think the invention might be traced back earlier still, even through our own Biblical records, and through the Vedas. There is nothing improbable, indeed, in the hypothesis of a very early origin of Greek fire; for there are an immense number of minor historical details, which would lead,

by circumstantial evidence, to the conclusion that the discovery is traceable to what may be called the second grand historic period of the world's history. In law a great many human lives have been taken on evidence infinitely less reliable; but men of science being naturally, from their love of the demonstrative, the antipodes of the lawyer, and having no legal subtleties, shams, and glib inferences from nothing in their hearts, despise so-called circumstantial evidence, as meaning what the cleverest sophist can best present from the smallest data, and as unworthy of all serious regard. They therefore will go, I doubt not, as a man, with Gibbon, in believing nothing absolutely about Greek fire until they have clear knowledge of the time when the invention was actually used in warfare, which would bring it down to the ninth century.

This much we know: that there was, under the Constantines, a liquid substance which, discharged from a catapult, bow, or sling, ignited in the air spontaneously. We know that the fire thus produced was very terrible in its effects, and we learn that, as the use of gunpowder came to be better known, Greek fire became of no importance: gunpowder blew it out of the field.

It still remains an interesting question,—What was the nature of this Greek fire fluid? On this point nothing positive remains. The Princess Anna Comnena says it was composed of sulphur, resin, and oil. Roger Bacon is supposed to have given two of its constituents—viz., sulphur and saltpetre—but to have hidden the third in the absurd sentence (at least, to us absurd), "Luru vopo vir Can utriet!" but in the sentence referred to, Bacon may be referring to gunpowder. In a word, it is hopeless, in the confusion surrounding the whole subject, to come to any decisive opinion. At the same time it is not improbable that, in the main, the formula of the Princess Anna Comnena is not far from the truth. Our difficulty in understanding her formula lies in the construction we put on the word "resin." We are not departing a letter from what is known at the present day in chemical science to suppose that a so-called resin was used, which, on admixture with oil and sulphur, formed a compound that would spontaneously ignite on exposure to the air. In another way we sometimes have fire produced in these days,—when saw-dust and oil are admixed, and what is called spontaneous combustion ensues.

The remarkable feature of the old Greek liquid is, that it must have been very safe in the mass, as safe as turpentine or common naphtha. Had not this been the case, it could never have been carried in wooden galleys or pumped through engines in torrents. It must have ignited in the air from the

extreme diffusion of its oxidizable constituents, and their exposure to oxygen: lighted in this way at one point, the flame would rapidly extend, with explosion; and the fire, as Joinville states, would come down with the velocity of lightning.

I shall take occasion at some future day to lay before the public some carefully elicited facts, of an experimental order, in reference to the compound described by the Princess Anna Comnena; for the subject is one not of historical interest merely, but of national importance. I do not suppose that any fluid, such as is described by the Byzantine writers, will again be used in shells or during bombardment; but in these days, when every vessel has a steam-engine, and could have a forcing engine to be worked by steam, it might be that an enemy, supplied with a combustible fluid such as has been described, would prove of terrible danger in attacking wooden ships, especially those belonging to the mercantile marine.

MODERN GREEK FIRE.

In order to understand the revival of "liquid fire," or, if we must still continue to call it so, "Greek fire," we must descend to the year 1680, the year in which was discovered the method of making a compound called a "*pyrophorus.*" In that year a chemist, named Homberg, endeavoured to extract from human fæces a colourless and odourless oil, which should have the power of fixing mercury. Macquer, who is the most accurate authority on these points, tells us that Homberg, when he had mixed the substances, upon which he was operating with different matters, was much surprised, while taking the *caput mortuum* of one of these mixtures out of the retort, four days after it had been operated on, to see it kindle and burn strongly as soon as it was exposed to the air. Homberg recollected that this was the residuum of a mixture of alum and human fæces from which he had obtained all that he could by means of a red heat. He repeated the process, and obtained the same result. Having published his discovery, other experimentalists also repeated the proceeding, the statement was fully confirmed and the name "pyrophorus"—πυρ (*pur*), fire; φερω (*pher'ō*), I bear—was soon applied to the spontaneously ignitible substance. From the Germans it also got the name of "luft zunder," or air tinder.

Until the year 1713 it was believed implicitly, that in order to make the pyrophorus, human fæces were essentially necessary; then Lemeri the younger instituted a new inquiry, in which he substituted honey for the other animal matter; the result was the same: afterwards he used sugar, then flour, and with like effects. He was followed by the eminent chemist, Dr. Lejay de Savigny, who clearly proved, that by the addition of any

inflammable body whatever, a pyrophorus may be made of all such substances as contain vitriolic acid combined either with earth, or with an alkaline salt, or with a metallic substance. Little improvement in the composition of the pyrophorus was introduced until the time of Gay Lussac, with whose name all moderns are familiar. Gay Lussac modified the process by placing lamp-black, instead of the animal matters named, in the retort. A little further on, sulphate of magnesia was substituted by the same chemist for alum; and at last the following formula was given as the best for an active pyrophorus: lamp-black, 15 parts; sulphate of potassa, 27·3 parts. This compound ignites in the air with great rapidity, yielding sulphurous acid in large quantities, and setting fire in any open place to all combustible matter, with an energy that is peculiarly its own.

The pyrophorus remained up to our own time a substance, mainly, of chemical interest. It was exhibited at lectures as a means for showing off a startling experiment, but not more. I can find indeed but one passage in chemical literature which refers to the use of spontaneously inflammable substances in war. That sentence is in the article on Gunpowder in the chemical essays of the learned Dr. Watson, published in 1793. He there says, in speaking of the antiquity of gunpowder:—

> There are substances in nature from the combination of which it is possible to destroy a ship, a citadel, or an army, by a shower of liquid fire spontaneously lighted in the air. Every person who is aware of the dreadful fiery explosion which attends the mixture of two or three quarts of spirit of turpentine with strong acid of nitre, must acknowledge the truth of the assertion; but the simple knowledge of effecting such a destruction is a very different matter from the knowledge of its practicability, though future ages may, perhaps, invent as many different ways of making these substances ignite in the air, so as to fall down in drops of fire, as have been invented in making gunpowder since the time of Bacon.

We may pass from the time of Dr. Watson to the year 1853. In the latter year, the subject of "liquid fire" began to occupy the attention of Mr. Wentworth Scott, then a student of chemistry at the Royal College of Chemistry in Oxford Street. Mr. Scott commenced his work by making a pyrophorus; and, after various modifications he formed one which promised to be most effective, and which, I believe, still might be used with considerable effect. He brought a specimen of this to me, at Mortlake, where I then resided, and showed to me its properties by filling a small glass shell with the substance, and then throwing the shell against a high wall in a garden, so as to break the glass and distribute the contents. As the solid particles descended, they burst into flame with great force, and

descended to the earth in a perfect shower of flame, burning for some time afterwards with great intensity. A few days later, Mr. Scott came again, bringing what he called "liquid fire;" bringing, that is to say, a solution which on being shot into the air burst into fire spontaneously, and which, spread over any surface exposed to the air, also burst into flame. Mr. Scott made some of this solution in my laboratory, and we at once tried its effects. I tipped arrows with tow, and, saturating the tow with the liquid, propelled the arrows from a bow; the tow invariably took fire spontaneously in the air, and combustible articles into which the arrows were driven were fired with wonderful rapidity and certainty.

Within a few weeks after the production of this liquid, Mr. Scott had devised a shell in which it could be placed, so as to make it available for purposes of war. This shell consisted of two parts; of an outward part and of an inner or exploding tube. The outer part or cavity was to be charged with the fluid and closed; the exploding tube was to be filled with ordinary explosive matter that could be discharged, either by a fusee or by percussion. On the discharge, the whole shell would burst, and the contained spontaneously igniting fluid would be distributed.

After witnessing Mr. Scott's numerous experiments, I urged him at once to lay them before the Board of Ordnance. He did so, and was received several times. The Russian war was in progress at the period when Mr. Scott was being treated with by this Board. The members were anxious to handle the newly proposed implement of war, but were either too much afraid of it, or were too bound down to official routine to be actuated by the same decision and common sense that men of business are given to cultivate. They simply played with the question (I can use no other word), dandled it, took it up warmly, and then put it down again as if they had themselves been burnt, without fire. They asked for an experiment of Mr. Scott. He did many successfully: they promised to give him an experiment with a gun and a shell; but when he went to perform it, he was advised that he must find shells at his own expense. There were hundreds of shells ready made and belonging to the country, which would have answered his purpose, but he was refused the use of them. He must have his own shells made. Naturally disgusted with the indecision and narrowness of these circumlocution officials, Mr. Scott withdrew from the inquiry and was by-and-by supplanted by another candidate with liquid fire, who in time also was allowed to sink into neglect;—I refer to Captain Disney. Mr. Scott's researches nevertheless were not lost. A very ingenious and enthusiastic officer, Captain Norton, whose valuable inventions have been but poorly appreciated, took up the subject,

and invented a small shell for an ordinary rifle, which would carry sufficient liquid fire to do immense mischief. The shell burst, or rather broke, on striking, and set free the fluid. With one of these shells, and with his own rifle, Captain Norton, at six hundred yards, could fire a piece of ordinary sailcloth, stretched out like a sail, with absolute precision. I calculated that eighty men, armed with Captain Norton's piece, could plant in a wooden ship, at six hundred yards' distance, one gallon of liquid fire fluid every four minutes. Taking all failures fully into account, it were impossible for a ship so treated to endure long. She must soon be on fire in several hundred points, and, what is more, she never could be safe again: for though the fire were effectually suppressed at the moment, the chances are that it would break out at a subsequent period.

Foreseeing the application of liquid fire in warfare, and being aware that the Russian government was actively extending inquiries on the application of chemistry in warfare, I communicated to the *Times* a letter on the whole subject, which letter was published in 1855. I explained there what Mr. Scott had done, and what might yet be done. The communication, copied largely into English and continental journals, passed to America, and was made the subject of considerable comment there.

With the close of the Russian war the question of liquid fire dropped, and we hear no more of it until this year, when we find that General Gilmore, on the second Thursday in August, threw shells charged with Greek fire into Charleston. That the effect, however partial, was sufficiently terrible, is proved by the fact that the Confederate general (Beauregard) sent back a denunciation of the missile forwarded to him by the cannon's mouth; declaring it to be the most villanous compound ever used in war.

Since then, Gilmore has from time to time used "Greek fire." Why he has not used it more, is due to the fact that his shells for projecting it were not perfect. Some of them were intended to burst by percussion, but failed; in others, the fusee employed did not answer; the shell either burst at short distance, or fell without bursting, and was obtained by the enemy, and put out before doing harm. At Springfield, a new fusee and shell, for the special purpose of "Greek fire shells," are being, I believe, prepared at this time, so that we are sure to hear more on the subject if the war in America continues.

From these facts we may pass to the consideration of the composition, properties, and mode of action of modern Greek fire. The first thing worthy of note is that the prin-

ciple is the same in this as in the ancient method. In both cases, a body greedy, under favourable conditions, for oxygen, bursts into flame on being distributed over a wide surface in the air, owing to the fact of the combination of its oxidable parts with the oxygen of the air. In the old Greek fire, the burning body was probably a hydro-carbon; in the modern, the body commonly used is phosphorus. There is, at the present time, in England, a patent by a gentleman named Macdonald, in which the composition of the fluid used is given as phosphorus, bisulphide of carbon, and naphtha. This composition, which has been described by its patentee in the columns of one of the daily papers, differs somewhat in detail from that of Mr. Scott, but it answers as well as need be for the purpose of explaining the mode of action of the fluid.

When widely distributed and exposed to the air, one of the ingredients of this fluid, the phosphorus, combines eagerly with oxygen, and bursts into flame. If phosphorus be merely pressed out over a wide surface in a thin layer, it begins to burn, and the thinner the layer the quicker the combustion. It would, of course, be too troublesome to carry out extension of phosphorus by pressure for the use of the soldier, and so another plan is adopted. It happens that phosphorus is extremely soluble in the fluid known as bisulphide of carbon. In this fluid phosphorus dissolves almost as sugar dissolves in water. Rendered soluble in the bisulphide of carbon, the phosphorus remains as unchanged phosphorus spread over a large surface of a fluid which prevents it from burning so long as it is in contact with it. The solution of phosphorus thus prepared, if put in a closed bottle, may be kept for years without undergoing any change, and without danger. I have some that has been in bottle for seven years, and it is the same as ever. But now comes a new fact. Bisulphide of carbon is a volatile body at ordinary temperatures; phosphorus is not volatile. Whenever, therefore, the solution of bisulphide of carbon and phosphorus is poured over any surface in the open air, the bisulphide of carbon, being volatile, evaporates, leaving the phosphorus distributed in a fine layer. Thus exposed, the oxygen of the air unites with the phosphorus, flame is produced, and any other combustible body is fired.

The principle once established, endless modifications may be introduced upon it: for instance, Mr. Macdonald adds naphtha, which, when fired by the phosphorus, burns with great fury. Mr. Scott has a method that has not yet been published, by which the fluid continues to burn even if it be covered with water: and there would be no difficulty in so producing it, that it should be absolutely unextinguishable, until it was itself burnt out.

The occurrence of flame—that is to say, the moment of combustion—is not, however, always to be calculated on with precision. The temperature of the air, the force of the wind, and the extent of surface over which the fluid is spread, all make great differences. Thus, in an experiment with a specimen of Scott's liquid fire fluid, I found that, at a temperature of 63° Fahrenheit, with a fair wind blowing, combustion took place in four minutes and a half, the fluid being distributed over dry wood; but when the same fluid was distributed in the same way, and at the same time, over moist wool, combustion was delayed for half an hour. It is, at the same time, quite unnecessary to dwell on such differences as are here described: to the practical man they would be infinitely less difficult to meet than many others, occurring in the management of weapons of war. The engineer would have necessarily to make his own calculations on each firing, taking into account the temperature, the wind, and the character of the structure on which the fluid was about to be cast.

Regarding Greek fire as we at present understand it in England, I have only one other word to add, and that is most important. I have many times tried to impress it, and must, by repetition, do so again. It is a caution. It is this: that if we were at war with any nation, and that nation were to throw a gallon of liquid fire fluid into any one of our wooden ships, that ship would never be absolutely safe again. The combustion might be prevented for the moment; it might be (assuming always that Mr. Scott's new compound is not in question) suppressed after combustion; but the fire, after all, is only suppressed: that is the great point. So soon as the water has evaporated or so soon as the cover is removed—though a month, a year, a century had elapsed—the fire would break out; and, paradoxical as it may seem, the more effectual the means of suppression had been, the more determinate would be the combustion when that suppression was removed.

I can consider no disaster more terrible than the lodgment of a few shells of Greek fire fluid on board a wooden vessel of war. What if such a vessel should even come out of a great fight victorious! Whither between her beams, and floorings, and crevices has the inflammable liquid not permeated? How safe is her magazine? When her carpenters afterwards, at any time, are taking her to pieces, in parts, for repair, what guarantee is there they shall not remove boards that are, on exposure, transformed into gigantic self-lighting lucifer matches?

It remains only for me to describe, in brief terms, such facts as are known in relation to American Greek fire. The scientific narrative will then be as complete as it can be rendered at the present moment.

The American pyrophorus is stated to have been invented by Levi Short. It is somewhat difficult to arrive at any correct conclusions as to the precise character of the composition employed. I believe, however, that two forms are resorted to. In one of these a fluid is used, as in Mr. Scott's plan; the fluid is simply poured into a shell, and the shell, in exploding, discharges its contents, ignition taking place on exposure to the air; the flame produced is described as yellowish and dull, as not very vigorous in action, and as evolving a white smoke. There can be no doubt that the fluid exhibiting these characteristics, on ignition, consists simply of phosphorus dissolved in bisulphide of carbon, and it is also probable that, as an invention, it is an imitation of the English patent.

But there is another description of American Greek fire which is new in its details. It is described that, in this case, the spontaneously combustible material is of a dark colour, and is enclosed in tin tubes about four inches long, and lightly closed at one end. These tubes, when opened at the end, spontaneously ignite, on exposure to the air, at the open end, and burn for so long a time as twenty minutes with a brisk flame, evolving a strong smell of sulphur. When they are opened high up in the air, the combustible matter falls in a stream or shower of fire. From the description thus given, there can, I think, be little doubt that the substance used is the old pyrophorus of Gay Lussac, the composition of which has been given above. Or it may consist of common gunpowder saturated with bisulphide of carbon containing a very small quantity of phosphorus in solution. The tin tubes containing the spontaneously combustible body are packed in a shell having a tube for the charge of powder that is to produce rupture of the shell. The isolation of the combustible matter in separate tubes is new, and is an ingenious improvement. It happens often, that when a globe containing the combustible stuff is burst by discharge of powder, the ignition takes place immediately, and the effect would be too rapid to be injurious to an enemy. By placing the matter that is to ignite in different chambers or cylinders, this is avoided; the shell on bursting distributes the tin cases like so many fragments; these on falling easily break, set free their contents, and become so many centres of flame.

In practice, the results obtained from Greek fire, when it is thrown from a shell, are wanting in precision. It seems that General Gilmore first used percussion shells, which were to explode on striking, and to distribute the pyrophorus. The shells did not act correctly; many of them fell without being discharged. The fact led the general to apply for a peculiar fusee, which should fire the powder with such accuracy, that when the

shell was crossing a given spot, it should burst in the air, and rain down fire on the place beneath. There is as yet great expense in the manufacture of the perfect shells and fusees; a circumstance which fully accounts for the present limited application of the principle, in the great American contest for the freedom of the slave.

For my own part, I am somewhat in doubt whether a shell, as the projectile of Greek fire, will be retained in use. It is more probable that a catapult worked by a steam-engine will be found the best means of throwing the combustible. If this plan were adopted, the liquid would merely require to be enclosed in earthenware or glass jars, that would break on contact with solid matter, in falling. With a properly constructed engine, so contrived as to throw liquid fire in earthenware or glass globes of six inches diameter, ten thousand gallons of the combustible could easily be thrown, per hour, upon any given point within range.

I have now placed before the reader the facts *practically* known in respect to Greek fire, and its applications in war. But it must not be inferred that all that has thus been done is all that science can do. I feel it a duty to state openly and boldly, that if science were to be allowed her full swing, if society would *really* allow that "all is fair in war," war might be banished at once from the earth as a game which neither subject nor king dare play at. Globes that could distribute liquid fire could distribute also lethal agents, within the breath of which no man, however puissant, could stand and live. From the summit of Primrose Hill, a few hundred engineers, properly prepared, could render Regent's Park, in an incredibly short space of time, utterly uninhabitable; or could make an army of men, that should even fill that space, fall with their arms in their hands, prostrate and helpless as the host of Sennacherib.

The question is, shall these things be? I do not see that humanity should revolt; for would it not be better to destroy a host in Regent's Park by making the men fall as in a mystical sleep, than to let down on them another host to break their bones, tear their limbs asunder, and gouge out their entrails with three-cornered pikes;—leaving a vast majority undead, and writhing for hours in torments of the damned? I conceive, for one, that science would be blessed in spreading her wings on the blast, and breathing into the face of a desperate horde of men a prolonged sleep—for it need not necessarily be a death—which they could not grapple with, and which would yield them up with their implements of murder to an enemy that in the immensity of its power could afford to be as merciful as Heaven.

The question is, shall these things be? I think they must be. By what compact can they be stopped? It were improbable that any congress of nations could agree on any code regulating means of destruction: but if it did, it were useless; for science becomes more powerful as she concentrates her forces in the hands of units, so that a nation could only act, by the absolute and individual assent of each of her representatives. Assume, then, that France shall lay war to England, and by superior force of men should place immense hosts, well armed, on English soil. Is it probable that the units would rest in peace and allow sheer brute force to win its way to empire? Or put English troops on French soil, and reverse the question?

To conclude. War has, at this moment, reached, in its details, such an extravagance of horror and of cruelty, that it cannot be made worse by any art, and can only be made more merciful by being rendered more terribly energetic. Who that had to die from a blow would not rather place his head under Nasmyth's hammer, than submit it to a drummer-boy armed with a ferule?

These thoughts are submitted in order to call forth more thought: this whole paper, in fact, is essentially dedicated to the Peace Party, for the consideration of its members, and as indicating a way, infinitely shorter than their own, by which their great objects may be achieved. Let them urge the Government to entrust men of science, under proper superintendence, to prepare, as they list, known, but yet unformed, engines of destruction; and in a very short interval the nations may, in truth, turn their swords into ploughshares and learn war no more.

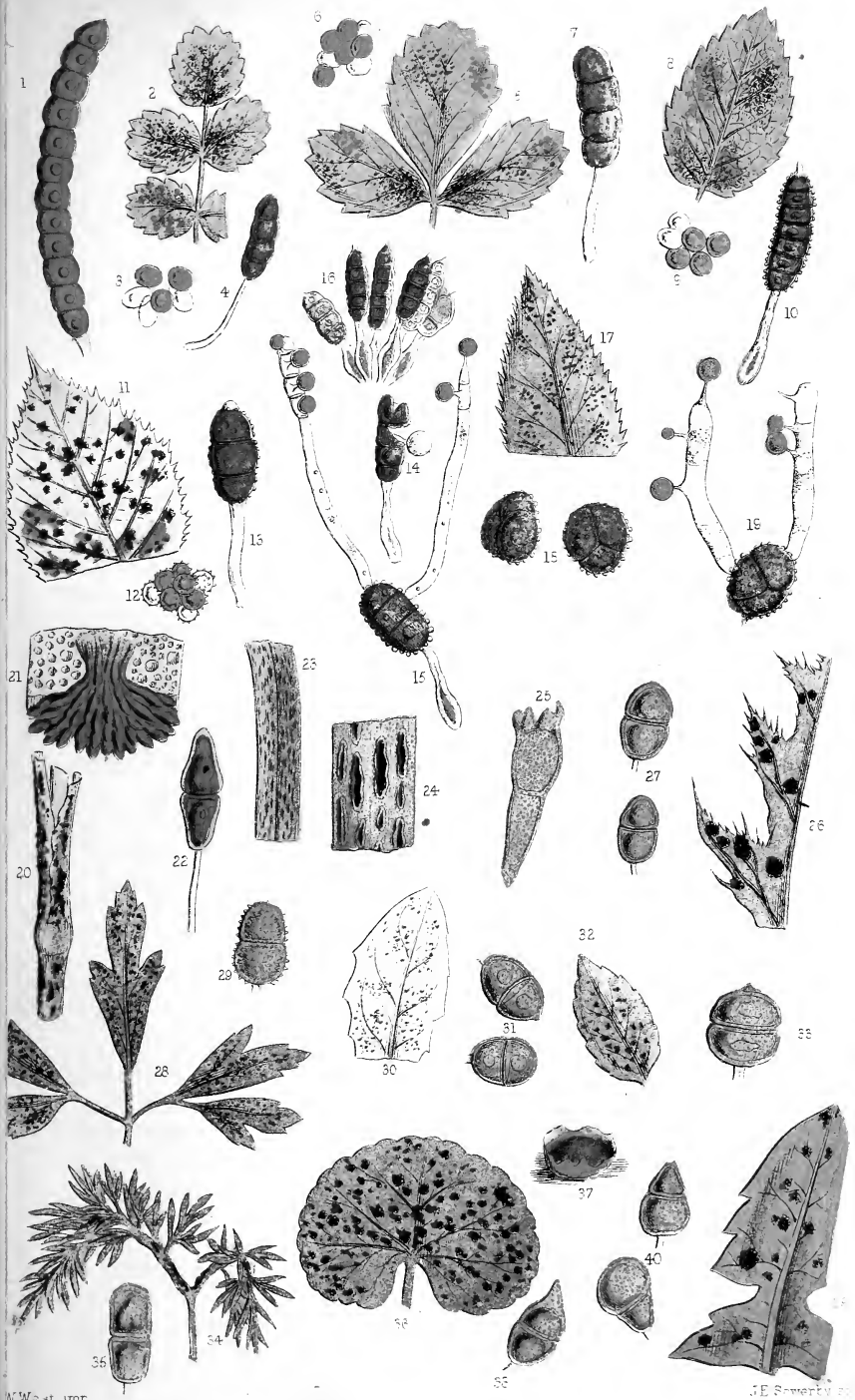
MICROSCOPIC FUNGI.

MILDEW AND BRAND.

BY M. C. COOKE.

DR. WITHERING'S "Arrangement of British Plants" in 1818 reached its sixth edition. This is less than half a century ago, and yet the whole number of species of Fungi described in that edition was only 564, of which three hundred were included under the old genus *Agaricus*. Less than eighty of the more minute species of Fungi, but few of which deserve the name of microscopic, were supposed to contain all then known of these wonderful organisms. Since that period, microscopes have become very different instruments, and one result has been the increase of Withering's 564 species of British Fungi to the 3,078 enumerated in the "Index Fungorum Britannicorum." By far the greater number of species thus added depend for their specific, and often generic characters, upon microscopical examination. The proportion which the cryptogamic section bears to the phanerogamic in our local Floras before 1818, now almost involuntarily causes a smile. Even such authors as were supposed to pay the greatest possible respect to the lower orders of plants could never present an equal number of pages devoted to them, as to the higher orders. Relhan, for instance, only occupies one-fifth of his "Flora Cantabrigiensis," and Hudson one-fourth of his "Flora Anglica," with the Cryptogamia. At the present time, it will be seen that, with a liberal allowance for "hair-splitting," the number of British species of flowering plants scarcely exceeds two-thirds of the number of Fungi alone, not to mention ferns, mosses, algæ, and lichens, and yet we have no "Flora" which contains them, and but a minority of our botanists know anything about them. If we need excuse for again directing attention to some of the most interesting of one group of these plants, let the above remarks suffice in lieu of formal apology.

"Mildew" is just one of those loose terms which represent no definite idea, or a very different one to different individuals. Talk of *mildew* to a farmer, and instantly he scampers mentally over his fields of standing corn in search of the brown lines



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NATURAL HISTORY.

or irregular spots which indicate the unwelcome presence of *Puccinia graminis*, known to him, and to generations of farmers before him, as "mildew." Try to convince a Norfolk farmer that anything else is "mildew," and he will consider you insane for your pains. Speak of *mildew* in your own domestic circle, and inquire of wives, or daughters, or servants, what it means, and without hesitation another, and even more minute species of fungus, which attacks damp linen, will be indicated as the true mildew, to the exclusion of all others; and with equal claims to antiquity. Go to Farnham, or any other hop-growing district, and repeat there your question,—What is *mildew?*—and there is every probability that you will be told that it is a kind of mould which attacks the hop plant, but which differs as much from both the mildew of the farmer and the laundry-maid as they differ from each other. The vine-grower has his mildew, the gardener his mildewed onions, the stationer his mildewed paper from damp cellars, the plasterer his mildewed walls, and in almost every calling, or sphere in life, wherever a minute fungus commits its ravages upon stock, crop, or chattels, to that individual owner it becomes a bug-bear under the name of "mildew." Reluctantly this vague term has been employed as a portion of the sub-title to this paper, but it must be limited in its application to the "mildew of corn," known to botanists as *Puccinia graminis*, and *not* to include the numerous other microscopic Fungi to which the name of *mildew* is often applied.

The origin of this term and its original meaning appear to be alike obscure. A singular proof of the ignorance which prevails in regard to all the fungal diseases of corn, may be found in the fact that at least one of our best etymological dictionaries states that the *mildew* in corn is the same as the *ergot* of the French. Had the writer ever been a farmer, he would have known the difference; had he ever seen the two, he could scarcely have made such a mistake. It is barely possible for him ever to have heard the ergot of grain called by the name of *mildew*.

How long this disease has been known, is another unsolved problem. About the middle of the last century a tract was published on this subject in Italy, but this was probably not even the first intimation of its fungoid character. Before such conclusion had been arrived at, men may have struggled in the dark, through many generations, to account for a phenomenon with which they were doubtless familiar in its effects. In 1805, Sir Joseph Banks published his "Short Account," illustrated by engravings from the inimitable drawings of Bauer, whereby many in this country learnt, for the first time, the true nature of *mildew*.

With a view to the clearer understanding of these parasites in the phases of their development, let us select one, and we cannot do better than adhere to that of the wheat and other graminaceous plants. A fine day in May or June dawns upon our preparations for a stroll, far enough into the country to find a wheat-field. Even now, with the area of the metropolis constantly widening, and banishing farmers and wheat-fields farther and farther from the sound of Bow-bells, a corn-field may be reached by a good stiff walk from Charing-Cross, or a sixpenny ride at the most, in nearly any direction. Having reached the field, it may be promised that a walk into it of less than twenty yards, will be sure to reward you with the fungus we are in quest of. Look down at the green leaves, especially the lower ones, and you will soon find one apparently grown rusty. The surface seems to be sprinkled with powdered red ochre, and grown sickly under the operation. Pluck it carefully, and examine it with a pocket lens. Already the structure of a healthy leaf is familiar to you, but in the present instance the cuticle is traversed with numerous longitudinal cracks or fissures, within which, and about their margins, you discern an orange powder, to which the rusty appearance of the leaf is due. Further examination reveals also portions in which the cuticle is distended into yellowish elongated pustules, not yet ruptured, and which is an earlier stage of the same disease. This is the "rust" of the agriculturist, the *Trichobasis rubigo vera* of botanists, the first phase of the corn mildew.

To know more of this parasite, we must have recourse to the microscope; having therefore collected a few leaves for this purpose, we return homewards to follow up the investigation. We will not stay to detail the processes of manipulation, since these will not offer any deviations from the ordinary modes of preparation and examination of delicate vegetable tissues.

The vegetative system of the "rust," and similar fungi, consists of a number of delicate, simple, or branched threads, often intertwining and anastomosing, or uniting one to the other by means of lateral branchlets. These threads, termed the mycelium, penetrate the intercellular spaces, and insinuate themselves in a complete network amongst the cells of which the leaf, or other diseased portion of the plant, is composed. High powers of the microscope, and equally high powers of patience and perseverance, are necessary to make out this part of the structure. We may regard the whole mycelium of one pustule, or spore-spot, as the vegetative system of one fungal plant. At first this mycelium might have originated in a number of individuals, which afterwards became confluent and combined into one for the production of fruit, that is to

say, an indefinite number of points in the vicinity of the future mycelium developed threads; and these, in the process of growth, interlaced each other, and ultimately, by means of transverse processes, became united into one vegetative system, in which the individuality of each of the elementary threads became absorbed, and by one combined effort a spore-spot, or cluster of fruit, is produced. In the first instance a number of minute, transparent, colourless cellules are developed from the mycelium: these enlarge, become filled with an orange-coloured endochrome, and appear beneath the cuticle of the leaf as yellowish spots. As a consequence of this increase in bulk, the cuticle becomes distended in the form of a pustule over the yellow cellules, and at length, unable longer to withstand the pressure from beneath, ruptures in an irregular more or less elongated fissure (as in fig. 24), and the yellow bodies, now termed *spores* (whether correctly so, we do not at present inquire), break from their short pedicels and escape, to the naked eye presenting the appearance of an orange or rust-coloured powder. In this stage the spores are globose, or nearly so, and consist of but one cell (resembling figs. 3, 6, and 9). It will afford much instructive amusement to examine one of these ruptured pustules as an opaque object under a low power, and afterwards the spores may be viewed with a higher power as a transparent object. The difference in depth of tint, the nearly colourless and smaller immature spores, and the tendency in some of the fully matured ones to elongate, are all facts worthy of notice, as will be seen hereafter.

A month or two later in the season, and we will make another trip to the cornfield. Rusty leaves, and leaf-sheaths, have become even more common than before. A little careful examination, and, here and there, we shall find a leaf or two with decidedly brown pustules intermixed with the rusty ones, or, as we have observed several times during the past autumn, the pustules towards the base of the leaf orange, and those towards the apex reddish brown. If we remove from the browner spots a little of the powder, by means of a sharp-pointed knife, and place it in a drop of water or alcohol on a glass slide, and after covering with a square of thin glass, submit it to examination under a quarter-inch objective, a different series of forms will be observed. There will still be a proportion of sub-globose, one-celled, yellow spores; but the majority will be elongated, most with pedicels or stalks, if they have been carefully removed from the leaf, and either decidedly two-celled, or with an evident tendency to become so. The two cells are separated by a partition or dissepiment which divides the original cell transversely into an upper and lower cell, with an external constriction in the plane of the dissepi-

ment (Plate VII. fig. 22). These bilocular, or two-celled spores are those of the "corn mildew" (*Puccinia graminis*), which may be produced in the same pustules, and from the same mycelium, as the "corn rust," but which some mycologists consider to be a distinct fungus, others only a modification or stage of the same fungus. After an examination of the different forms in the allied genera to which this paper is devoted, we shall be able with less of explanation and circumlocution to canvass these two conflicting opinions.

Let us proceed, for the third and last time, to our cornfield, when the corn is nearly or fully ripe, or let us look over any bundle of straw, and we shall find blackish spots from the size of a pin's head to an inch in length, mostly on the sheaths of the leaves, often on the culm itself. This is the fully developed *mildew*, and when once seen is not likely afterwards to be confounded with any other parasite on straw (fig. 20). The drawings of Bauer have already been alluded to. Bauer was botanical draughtsman to George III., and his exquisite drawings, both of the germination of wheat and the fungi which infest it, are marvels of artistic skill. A reduced figure from part of one of his drawings is given in the plate (fig. 21) exhibiting a tuft of the bilocular spores of *Puccinia graminis* bursting through a piece of wheat straw. These closely-packed tufts or masses of spores, when examined with a common lens, seem, at first, to resemble the minute sorus of some species of fern; but when seen with higher powers, the apparent resemblance gives place to something very different. The tufts consist of multitudes of stalked bodies, termed spores, which are constricted in the middle and narrowed towards either extremity. The partition, or septum, thrown across the spore at the constriction, separates it into two portions, each of which consists of a cell-wall enclosing an inner vesicle filled with the endochrome (fig. 22) or granular contents, in which a nucleus may often be made out. This species of *Puccinia* is very common on all the cereals cultivated in this country, and on many of the grasses. A variety found on the reed was at one time considered a distinct species, but the difference does not seem sufficient to warrant a separation. However near some other of the recognized species may seem to approximate in the form of the spores, a very embryo botanist will not fail to observe the distinctive features in the spores of the corn mildew, and speedily recognize them amongst a host of others; subject as they may be to slight deviations in form, resulting either from external pressure, checks in development, or other accidental circumstances, or the variations of age.

There is no doubt in the minds of agriculturists, botanists,

savans, or farm-labourers, that the mildew is very injurious to the corn crop. Different opinions may exist as to how the plants become inoculated, or how infection may be prevented or cured. Some have professed to believe that the spores, such as we have seen produced in clusters on wheat straw, enter by the stomata, or pores, of the growing plant, "and at the bottom of the hollows to which they lead, they germinate and push their minute roots into the cellular texture." Such an explanation, however plausible at first sight, fails on examination, from the fact that the spores are too large to find ingress by such minute openings. It is improbable that the *spores* enter the growing plant at all. The granular contents of the spores may effect an entrance either through the roots or by the stomata, or the globose bodies produced upon the germination of the spores, may be the primary cause of infection. We are not aware that this question has been satisfactorily determined. It is worthy of remembrance by all persons interested in the growth of corn, that the mildew is most common upon plants growing on the site of an old dunghill, or on very rich soil. As the same *Puccinia* is also to be found on numerous grasses, no prudent farmer will permit these to luxuriate around the borders of his fields, lest they should serve to introduce or increase the pest he so much dreads.

The germination of the spores of the corn mildew is a very interesting and instructive process, which may be observed with a very little trouble. If the spores be scraped from the sori of the preceding year (we are not sure that those of the current year will succeed) and kept for a short time in a damp atmosphere under a glass receiver, minute colourless threads will be seen to issue both from the upper and lower divisions of the spores. These will attain a length several times that of the spores from whence they spring. The extremities of these threads ultimately thicken, and two or three septæ are formed across each, dividing it into cells, in which a little orange-coloured endochrome accumulates. From the walls of each of these cells, or joints, a small pedicel, or spicule, is produced outwards, the tip of which gradually swells until a spherical head is formed, into which the orange-coloured fluid passes from the extremities of the threads.* A quantity of such threads, bearing at their summits from one to four of these orange-coloured, spherical, secondary fruits, supply a beautiful as well as interesting object for the microscope. When matured, these globose bodies, which Tulasne has called *sporidia*, fall from the threads, and commence germinating on their own

* Similar in all essential particulars to the germination of *Aregma* (fig. 15).

account. It is not impossible that the sporidia, in this and allied genera, may themselves produce a third and still more minute fruit, capable of diffusion through the tissues of growing plants or gaining admission by their stomata. Nothing of the kind, however, has yet been of certainty discovered.

Forty other species of *Puccinia* have been recorded as occurring in Great Britain, to all of which many of the foregoing remarks will also apply—viz., such as relate to their two-celled spores being found associated with, and springing from, the same mycelium as certain orange-coloured one-celled spores; and also the main features of the germinating process.

A very singular and interesting species is not uncommon on the more delicate grasses, being found chiefly confined to the leaves, and produced in smaller and more rounded, or but slightly elongated, patches (fig. 23). We have met with it plentifully amongst the turf laid down in the grounds of the Crystal Palace at Sydenham, and also on hedge-banks and in pastures. The spores are rather smaller than those of *Puccinia graminis*, but like them much elongated, slightly constricted, and borne on persistent peduncles. The most prominent distinction may be found in the apices of the spores, which in this instance are not attenuated, but crowned with a series of little spicules, or teeth, whence the specific name of *coronata* has been derived (fig. 25).

The Labiate family of plants and its ally the Scrophulariaceæ are also subject to the attacks of several kinds of Brand, a name, by the bye, often applied locally to the corn mildew and other similar parasites, and which may have originated in the scorched or *burnt* appearance which the infected parts generally assume. In the former natural order the different kinds of mint, the ground ivy, the wood-sage, and the betony, and in the latter, the water-figwort and several species of veronica, or speedwell, are peculiarly susceptible; and on most a distinct species of *Puccinia* is found. To provide against doubt which the less botanical of our readers may possess of the meaning or value of the term *Puccinia*, which has already occurred two or three times in this communication, a brief explanation may be necessary, which more scientific readers will excuse.

In botany, as in kindred sciences, acknowledged species have their trivial, or specific name, generally derived from the Latin. In the last species referred to, this was *coronata*, meaning *crowned*, in reference to the coronated apex of the fruit. Any indefinite number of species with some features in common, are associated together in a group, which is termed a *genus*, and the term prefixed to the specific name of each species

constituting that genus is its generic name, also commonly derived from the Latin or Greek. In this instance, it is *Puccinia,* derived from the Greek *puka,* meaning *closely packed,* singularly applicable to the manner in which the spores are packed together in the pustules. The common features, or generic distinctions, of this genus, are uniseptate spores borne on a distinct peduncle.

In returning to the species found on Labiate plants, let us suppose ourselves to have strolled towards Hampstead Heath, and south of the road leading from Hampstead to Highgate, near certain conspicuous and well-known arches, built for a purpose not yet attained, are two or three muddy ponds nearly choked up with vegetation. Some fine autumnal afternoon, we must imagine ourselves to have reached the margin of the most northern of these ponds, and amidst a thick growth of reeds, sedges, and other water-loving plants, to have found the water-mint in profusion and luxuriance, with every leaf more or less occupied, on its under surface, with the yellow spores of a species of rust (*Trichobasis*) mixed with the browner septate spores of the mint brand (*Puccinia Menthæ*). This is common also on the horse-mint and corn-mint; we have found it on the wild basil and wild thyme, and once only on marjoram. Having collected as many leaves as we desire, and returned to home and the microscope, we proceed to examine them in the same manner as we have already examined the mildew, and as a result of such proceeding arrive at the following conclusions:—The pustules are small and round, never elongated as in the corn mildew, and generally confined to the under surface of the leaves (fig. 32). The spores are sub-globose, slightly constricted, and the two cells nearly two hemispheres with their flat surfaces turned towards each other (fig. 33). The form delineated in figure 37 is that of the sorus of many of the epiphytal brands, the centre being occupied by the closely-packed spores, surrounded to a greater or less extent by the remains of the ruptured epidermis.

Although the species of Puccinia (*P. glechomatis*) found on the leaves of the ground-ivy is said to be very common, we sought it in vain amongst every cluster of that plant met with during last summer and autumn, until, nearly despairing of finding it at all, we at last encountered a plot of ground-ivy covering the ground to the width of two or three yards and in length eight or ten, nearly every plant being attacked by the *brand.* This was in the corner of a pasture, and the only time we found infected plants. The fungus, however, may be as common as the plant in other localities. The pustules on the leaves are larger than those of the mints, and also confined to the inferior surface (fig. 36). The spores are elliptic and but

slightly constricted; the apex is often pointed, though not always so much as in our figure (fig. 38).

Of other species found on allied plants we have not considered it necessary to give figures, or write much. The betony brand (*P. Betonicæ*, D C.) does not seem to be common enough to be readily found by any one desiring to examine it for themselves; and the same may be said of the figwort brand (*P. Scrophulariæ*, Lib.), the wood-sage brand (*P. Scorodoniæ*, Lk.), and the speedwell brand (*P. Veronicarum*, D C.); all of these are, however, characterized by a distinct feature, or features, which have been considered of sufficient importance to constitute a separate species.

We have had occasion to refer incidentally to the brand found on the under surface of the leaves of the wood-anemone (*P. anemones*, P.). This is one of the earliest and commonest species. Go wherever the wood-anemone abounds, in any of the woods lying immediately to the north of the metropolis, or any of the woods in Kent, and from March to May it will not be difficult to find attenuated, sickly-looking leaves, with the under surface covered with the pustules of this brand, looking so like the sori of some fern (fig. 28) that it *has* been, and still *is*, sometimes considered as such. In Ray's "Synopsis" (3rd edition, 1724), it is described in company with the maidenhair and wall-rue ferns, a figure is given of it in the same work (t. iii. fig. 1), and it is stated,—"this capillary was gathered by the Conjuror of Chalgrave." When, afterwards, it was better understood, and the spots came to be regarded as true parasitic fungi, it still for a long time continued to bear the name, not even yet quite forgotten, of the Conjuror of Chalgrave's fern.

An examination of the spores, both collectively in the pustules, and separately under a high power, will not fail to convince any one who has examined only the species we have already alluded to, that this parasite on the anemone (*P. anemones*) is a true *Puccinia*, and a most interesting one. The two cells of the spores are nearly spherical, and the constriction is deeper and more positive than in any of the preceding. Moreover, the surface of the spore is minutely and beautifully echinulate, or covered with erect spines (fig. 29). Some few other of the species found in Britain have echinulate spores, but those are not common like the present. One word of caution to the amateur in search of the *Puccinia* on the anemone. It will be fruitless looking for it on the large foliaceous bracts of the flower stalk, since these may be turned up carefully, till the back aches with stooping, ere a solitary pustule will be found; but the true leaves, proceeding from the rhizomes, are certain soon to afford you specimens.

Everybody knows the dandelion, but it is not every one who has noticed the fungi found upon its leaves. These are most commonly of two kinds, or probably the unilocular and bilocular forms of the same species: the latter we have found in the month of May, and the former in August and September. The lower leaves of young seedlings have generally rewarded us with the best specimens of the septate-fruited brand (*Puccinia variabilis*, Grev.). The pustules occur on both sides of the leaf, and are very small and scattered (fig. 39). The spores are singularly variable in form: sometimes both divisions are nearly equal in size; sometimes the upper, and sometimes the lower, division is the smallest; occasionally the septum will be absent altogether; and more rarely, the spores will contain three cells. From the very variable character of the spores (fig. 40) the specific name has been derived.

No species in the entire genus makes so prominent an appearance as the one found on the radical leaves of the spear thistle (*Carduus lanceolatus*). This latter plant is exceedingly abundant, and so is its parasite (*Puccinia syngenesiarum*, Lk.). From the month of July till the frosts set in we may be almost certain of finding specimens in any wood. The leaves have a paler roundish spot, from one-twelfth to one-fourth of an inch in diameter, on the upper surface, and a corresponding dark brown raised spot on the under surface, caused by an aggregation of pustules, forming a large compound pustule, often partly covered with the epidermis. The individual pustules are small, but this aggregate mode of growth gives the clusters great prominence, and therefore they are not easily overlooked (fig. 26). Although not confined to this species of thistle, we have not yet found this *Puccinia* on any other plant. The spores are elliptical, rather elongated, constricted, and without spines (fig. 27).

Other species of *Puccinia* are found on Composite plants, but with none of these is the present fungus likely to be confounded, if regard be had to its pecular habit. The leaves, for instance, of the common knapweed (*Centaurea nigra*) are often sprinkled with the small pustules of the centaury brand (*Puccinia compositarum*, Sch.); these generally occupy the under surface of the lower radical leaves (fig. 30); occasionally a few of the pustules appear on the upper surface. We have not often found this fungus in the neighbourhood of London on the leaves of the knapweed, but, on the other hand, we have encountered it very commonly on those of the saw-wort (*Serratula tinctoria*). The spores are oval, scarcely constricted, and not attenuated in either direction (fig. 31). Other Composite plants than those above named are liable to attacks from this parasite.

In our school-days we remember to have spent many a stray half-hour digging for "earth-nuts," under which name we, as well as our elders and betters, knew the tubers of *Bunium flexuosum*. Not then, nor for many years after, did we notice, or regard if we did notice, the distorted radical leaves and leaf-stalks, and the blackish brown spots, which reveal the cause in the presence of a brand, or parasitic fungus, of this genus (*Puccinia Umbelliferarum*, D C.) which is extremely common on this, as well as some other allied plants. If any spot is searched where this plant grows in any profusion, before the flowering stalks have made their appearance above the surrounding grass, this *Puccinia* will be readily found by the twisted, contorted, sickly appearance of the infested leaves (fig. 34), the petioles of which are often swollen and gouty in consequence. The sporidia are shortly stalked and generally very much constricted. The species found on the stems of the hemlock, and also that on *Smyrnium Olusatrum*, are distinct; the spores of the latter being covered with tubercles or warts. During a botanical ramble through Darenth Wood in April of the year just passed away, in some parts of which the sanicle abounds, we found the bright, glossy leaves of this singular and interesting plant freely sprinkled with the pustules of a *Puccinia* (*P. Saniculæ*, Grev.), which is not at all uncommon on this, but has not hitherto been found on any other plant. Dr. Greville, of Edinburgh, was the first to describe this, as well as many other of our indigenous minute Fungi. For many years he has toiled earnestly and vigorously at the lower cryptogams, as evidenced by his "Scottish Cryptogamic Flora," published in 1823; and yet his continual additions to the records of science show him to be earnest and vigorous still.

We have by no means exhausted the catalogue of Fungi belonging to this genus found in Britain, nor even those commonly to be met with; but the fear of prolixity, and the desire to introduce a description of other forms into the space still remaining to us, prompt us to dismiss these two-celled brands with but a brief allusion to such as we cannot describe. Box-leaves are the habitat of one species, and those of the periwinkle of another. One vegetates freely on the leaves of violets through the months of July and August, and another less frequently on the enchanter's nightshade. Several species of willow-herb (*Epilobium*) are attacked by one *Puccinia*, and a single species by another. Plum-tree leaves, bean leaves, primrose leaves, and the half-dead stems of asparagus, have their separate and distinct species, and others less commonly attack the woodruff, bedstraw, knotgrass, ragwort, and other plants less common, more local, or, to the generality of the non-botanical, but imperfectly known.

In the spores of the species to which attention has been more specially directed we have types of the principal forms. In the "corn-mildew" they are elongated, and tapering towards either end; in the "coronated brand" the apex is crowned with spicular processes; in the "wind-flower brand" the entire spores are echinulate; in the "mint brand" they are globose; in the "composite brand" elliptic; in the "earth-nut brand," nearly cut in two at the septum; and in the "dandelion brand," so variable in form that no two are precisely alike. On the other hand, all are characterized by a transverse septum dividing each spore into two cells.

From this genus we pass to another, in which the spores are usually divided into three cells, and which, from this cause, has been named *Triphragmium*. Only one species of this genus has hitherto been found in this country, and *that* not very commonly, on the leaves of the meadow-sweet *Spiræa ulmaria* (fig. 17). Externally it much resembles, in the size and character of the pustules, many of the above-named brands, but when seen under the microscope this similarity disappears. In general outline the spores are nearly globose, and externally papillose. In one species, found on the Continent, but not hitherto in Great Britain, the spores are covered with curious long-hooked spines, by means of which they adhere tenaciously to each other. In germination, the spores of *Triphragmium* do not offer any noteworthy deviation from those of *Puccinia*,* and the chief interest of our indigenous species lies in the three-celled form of its spores, to which occasionally those of *Puccinia variabilis* approximate, and may be regarded as the link which unites the two genera.

The old story of "Eyes and no eyes" is too often literally true, not only with the children it was written to amuse and instruct, but also with children of a larger growth who scorn such baby tales, and disdain such baby morals. Out of more than a thousand indigenous species of microscopic fungi, of which there is generally some evidence afforded of their presence, visible to the naked eye, how few are there of the millions that inhabit our island who can count twenty species that they have ever seen; still fewer that have noticed one hundred. Amongst the twenty species known to the few will probably be included one which appears in autumn in prominent black spots, the size of a large pin's head, or half a turnip

* Mr. Currey has only seen the tips of the germinating threads swell, and become septate, each of the joints thus formed falling off and germinating without producing spherical sporidia; whilst Tulasne figures globular sporidia, as will be seen in our fig. 19, reduced from the figure by Tulasne.—(*Vide* Currey, in "Quarterly Journal of Microscopical Science," 1857, pp. 117, &c.)

seed with the flat surface downwards, sprinkling the under surface of blackberry leaves, with larger reddish, purplish, or reddish-brown spots on the upper surface to indicate the presence of the fungus beneath. Just at the time when blackberries are ripe, these spots are in perfection on the leaves, and *their* eyes must have been sadly at fault who could ever have gathered their own blackberries without seeing the discoloured leaves. The coloured spots on the face of the leaf are due to the diseased state of the tissues caused by the parasite on the opposite surface. As much of the leaf as contains two or three of the black pustules should be removed carefully with a knife or sharp scissors, and submitted to microscopical examination; each will be seen to consist of a dense tuft of blackish, elongated, stalked bodies, clustered as in fig. 16, but much more numerously and closely packed together. These are the spores of the blackberry brand (*Aregma bulbosum*, Fr.). A few of these spores should be removed on the point of a sharp penknife, placed on a glass slide with a drop of distilled water or alcohol, covered with thin glass, and then viewed with a quarter-inch objective. Each spore has a stalk longer than itself, thickened below, and containing a yellow granular core. The spore itself is much longer than in any of the *Puccinicæ*, of a dark brown colour, and apparently divided by several transverse partitions into three, or four, or more cells, the whole surface being covered with minute warts or prominences (fig. 13). In 1857, Mr. F. Currey investigated the structure of these spores, and the results of his experiments were detailed in the "Quarterly Journal of Microscopical Science." One conclusion arrived at was, that "the idea of the fruit consisting of sporidia united together and forming a chain, is certainly not in accordance with the true structure. The sporidia are not united to one another in any way, but, although closely packed for want of space, they are in fact free in the interior of what may be called a sporangium or ascus." To arrive at this conclusion, careful examination was necessary, and new modes of manipulation essential. The details of one method employed were to the following effect:—A sufficient number of spores were removed on the point of a lancet, and placed on a slide in a drop of alcohol. Before the spirit was quite evaporated, two or three drops of strong nitric acid were added, and the whole covered with thin glass. The slide was then warmed over a spirit-lamp, the acid not being allowed to boil, but only gradually heated to boiling point. By this means the fruit was found to consist of an outer membrane, nearly transparent, and studded with tubercles; that this membrane enclosed a number of cells which constituted the apparent joints, and which were naturally flattened at either

end by mutual pressure. When the outer membrane was dissolved or ruptured, these cells escaped, and became detached from each other. The cells, thus set free, exhibited a brownish or yellow ring around a paler area, in the interior of which an inner cell was visible, sometimes globular, often irregular in shape. The examination of the ring was not entirely satisfactory; it appeared to be sometimes marked with concentric lines having the appearance of wrinkles. The inner cell had granular contents and a central nucleus. When perfectly free they were spherical in form, with a distinct membrane of their own; and colourless, except when acted upon by re-agents. The means employed to determine the existence of these cells, was to soak the spores in muriatic acid, then upon pressure of the glass cover, the outer membrane and ringed cells were ruptured and the inner cell escaped (fig. 14).

Germination may be induced in these spores by keeping them in a moist atmosphere (fig. 15); but the mode does not differ from that described above as occurring in the "corn mildew." Mr. Currey writes:—"I know no microscopical object of greater beauty than a number of fruits of *Phragmidium* in active germination." By *Phragmidium* he means the *Aregma* of this paper, of which *Phragmidium* is a synonym.

Well may the reader remark on arriving thus far, "Does all this examination and detail refer to the fruit borne in the little blackish spots on bramble leaves, which I have hitherto overlooked?" Ay, and to several similar spots on other plants. Examine carefully the raspberry leaves in your garden, and you will probably find similar, but smaller, pustules also on the under surface. We say *probably*, because none of our British species seem to be equally uncommon with this. During the past year we examined hundreds of plants, and did not find a single pustule. Such a fate will not await you if you should proceed in the autumn to some chalky district where the burnet is common. Go, for instance, to Greenhithe or Northfleet, on the North Kent Railway, in August or September, where the burnet is plentiful, and the leaves will present the appearance of having been peppered beneath, from the number of minute pustules of the burnet brand scattered over the under surface (fig. 2, upper leaflets). Or if you prefer collecting nearer home, visit some neighbouring garden, if your own does not contain many roses, and the leaves will be found equally prolific in an allied species (fig. 8). Should gardens and roses be alike unattainable, any bank or wood will furnish the barren strawberry (*Potentilla fragariastrum*), and during the latter part of the summer, or in autumn, another species of *Aregma* will not be uncommon; also on the under surface of the leaves (fig. 5). All these

species will be found accompanied by the orange spores of species of *Lecythea*, which some mycologists consider to be distinct Fungi, and others to be merely forms or conditions of *Aregma*. These spores are represented in figs. 3, 6, 9, and 12. From the magnified figures of the spores of the different species of *Aregma* (figs. 4, 7, 10, and 13), it will be apparent that they have all certain features in common, *i.e.*, cylindrical spores containing from three to seven cells. This may be called the *generic* character, common to all the species of the genus *Aregma*. Again, each species will be observed to possess its own distinct features, which may be termed its *specific* character. In one, the apex of the spores will be obtuse, in another acutely pointed, in another bluntly pointed, &c. In one species the number of cells will usually be four, in another five or six, in another seven or eight. The stem in one species will be slender and equal, in another thickened or bulbous. So that in all there will be some permanent peculiarity for each not shared by the others.

One other form of brand, presenting, it is believed by some, generic differences from all that we have as yet noticed, remains to be briefly alluded to. This form appears to be very uncommon in this country, but, when found, is parasitic on the leaves of the great burnet (*Sanguisorba officinalis*), a plant of local distribution. The parasite appears to the naked eye in small tufts or pustules resembling those of an *Aregma*, but, when microscopically examined, the cells of the spores are found to be numerous, indeed, considerably more than in the most complex *Aregma* (fig. 1). This, however, seems to be the only distinction, for the cells are free in the interior of the investing membrane, and in all points of structure, in so far as it has been examined, identical with *Aregma*. Whether it is logical to consider a four-celled spore an *Aregma*, and a seven-celled spore an *Aregma*, and exclude a ten or twelve-celled spore from the same genus on account of the number of its cells, does not appear to us clearly answerable in the affirmative.

During the course of this paper we have passed rapidly through four genera of parisitic Fungi so nearly allied, that one is almost led to doubt the validity of the generic distinctions. These may be presented briefly thus,—

PUCCINIA	spores	two-celled.
TRIPHRAGMIUM.....	„	three-celled.
AREGMA	„	four to seven-celled.
XENODOCHUS	„	many-celled.

It has been seen that the habit, mode of growth, germination, and structure, except in the number of cells, scarcely differs;

but it is not our province here to enter upon the discussion of such a subject.

The association of one-celled orange-coloured spores with the brown two or more celled spores passed in review is another feature worthy of passing notice, which opens another field for discussion. It is generally admitted that these two forms are the production of the self-same mycelium or vegetative system, but it is not so generally admitted that they are but two forms or phases of the fruit of the same plant. It is not at all uncommon in the history of mycology to find two forms which were for a long time considered to be distinct plants producing different forms of fruit, and which bore different names, and were located in different genera, at length proved to be only the self-same plant in different conditions, and ending in one name being expunged from the list. Such a fate probably awaits, at no distant date, the orange spores which precede or accompany the species in the present genera. Already Tulasne and some others accord them no place in their system.

It may be added, for the benefit of any who wish to pursue the study of this interesting branch of Cryptogamic Botany, that the leaves of the plants containing the parasitic Fungi now noticed may be collected and preserved by drying between folds of blotting-paper, or the leaves of a book, and will retain their character, with the exception of colour in the orange forms, so as to be eligible for examination at any period of the year for twenty years to come. Each species, when dry, may be transferred to an old envelope, and labelled outside with the name, date of collection, and locality; and one hundred such envelopes will constitute a miniature herbarium in a very small compass.

MOULDS.

TWENTY years since and some of these little pests were altogether unknown, whilst others were only recognized and partly understood by a few scientific men. During the period to which we have alluded more than half the present species contained in the genus *Peronospora* had never been observed, and amongst these the most devastating of its tribe, the associate and undoubted cause of the potato disease.

Parasitic fungi are far more numerous, both in individuals and species, than most persons are aware, and cultivated

plants of all kinds are more or less subject to their ravages. Some are more susceptible than others, of which the corn and grass tribe, or *Graminaceæ*, as they are termed by botanists, is an example. Not less than thirty species have been recorded upon plants of this natural order, and of these nearly one-half are found upon the living plants. Upon the potato plant, again, no less than ten different kinds of Fungi have been described; whilst upon other and more fortunate plants only one or two parasites of this nature establish themselves.

Potato Mould.—Towards the close of the summer of 1845, in the course of a few weeks, every one became aware of the fact that a new disease had appeared which threatened the entire destruction of the potato crop. Until then it seemed to have been almost, although not entirely unknown. It first appeared in the Isle of Wight about the middle of August, and a week afterwards had become general in the South of England, and the next week there were but few sound samples of potatos in the London market. Early in September the disease had commenced its ravages in Ireland, and shortly afterwards it was discovered in Scotland. With the same rapidity it seems to have spread throughout Europe and North America, or at least the western portion of the former and the northern districts of the latter. It must not be imagined, however, that the Isle of Wight was the centre from which this disease spread over such an extended area and with such alarming rapidity. From this spot it doubtless made its first appearance that year amongst our own crops, but there is not the least doubt of its existence both on the continent of Europe and in North America in the previous year, and the farmers of Belgium had noted its appearance in the province of Liège as far back as 1842 and 1843. Other diseases had been observed affecting the potato crop before, and one which was also associated with a parasitic fungus had made its appearance in 1815. It is also exceedingly probable that, in a milder form, the murrain was present with us a year or two before it broke out to such an alarming extent. A correspondent to the *Gardener's Chronicle*, in 1844, notices it in the Isle of Thanet, and another testifies to its occurrence in districts of Ireland for two or three years previous to its general outbreak. The description of the disease in Canada, in 1844, contained in a letter addressed to Dr. Bellingham, and quoted by the Rev. M. J. Berkeley,* leaves no doubt of its identity :—

During the months of July and August (1844), we had repeated and heavy showers, with oppressive heat, and an atmosphere strongly charged with

* Journal of Horticultural Society of London, vol. i. p. 11.

electricity. Towards the close of the month of August I observed the leaves to be marked with black spots, as if ink had been sprinkled over them. They began to wither, emitting a peculiar, offensive odour; and before a fortnight the field, which had been singularly luxuriant, and almost rank, became arid and dried up, as if by a severe frost. I had the potatoes dug out during the month of September, when about two-thirds were either positively rotten, partially decayed and swarming with worms, or spotted with brownish-coloured patches, resembling flesh that had been frost bitten. These parts were soft to the touch, and upon the decayed potatoes I observed a whitish substance like mould.

Although this disease made its first appearance, in the middle of August, 1845, in the Isle of Wight, it had already appeared in Belgium in the same year, a month previously; and although it may have been noticed in other British localities in 1844, it was known in Canada and in St. Helena in the same year to a far greater extent, and in Liège as early as 1842. There are, therefore, good grounds for believing that the European centre was Belgium; but if M. Boussingault was correct in stating that "this malady is well known in rainy years at Bogota, where the Indians live almost entirely on potatoes," then it is not of European but American origin, and is probably derived from districts not far remote from those whence Europe first received the potato itself.

It would occupy too much space to detail the different theories and opinions relative to the causes of this disease to which 1845 and subsequent years gave birth. Suffice it to say, that the lapse of years has silently proved the majority of these to have been fallacious. All such as imputed to peculiar electric conditions, a wet season, or other meteorological influences, the disease which has re-appeared under different conditions and influences, and in seasons remarkable for dryness, are manifestly refuted; whilst its mycological origin has continued to gain adherents, and the gradual accumulation of fresh facts has almost placed it beyond dispute not only that the potato disease is accompanied by, but results from, fungal growths. Unfortunately, this disease has been so prevalent, more or less during the past eighteen years, that few have been without the opportunity of making themselves acquainted with its external appearance. To this may be added the minute and exact account of its development, as recorded by that excellent mycologist and careful observer the Rev. M. J. Berkeley, in 1846, and to which, even now, nothing of importance can be supplemented or abstracted:—

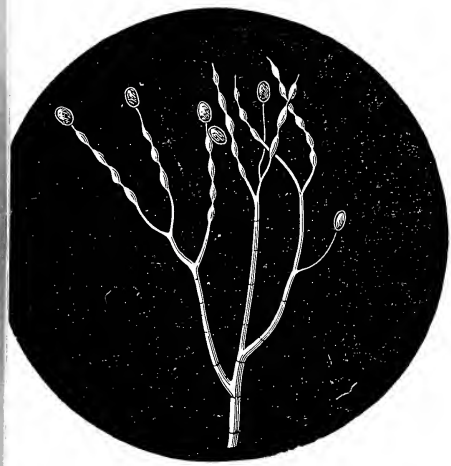
The leaves began suddenly to assume a paler, and at length a yellowish tint, exhibiting here and there discoloured spots. More or less coinciding with these spots, on the reverse of the leaves, appeared white mealy patches,

consisting of a minute mould, proceeding, either singly or in fascicles, from the stomata, and arising from an abundant branched mycelium creeping in every direction through the loose tissue beneath the cuticle. The upper surface rarely, if ever, exhibits the mould, it being almost physically impossible for its delicate threads to penetrate the closely-packed cells which, being arranged side by side, leave scarcely any intercellular passages. The mould, in a few hours from its first piercing the apertures of the stomata, perfects its fruit, and in so doing completely exhausts the matrix, which in consequence withers. No sooner have a number of the leaves been attached, than the stem itself is subject to change, becoming spotted here and there with dark brown patches, in which the cells are mostly filled with a dark grumous mass, without exhibiting any mucedinous filaments; though, occasionally, I have ascertained their presence. Very rarely fructifying but dwarfed specimens of the mould occur upon it. The stem now rapidly putrifies, the cuticle and its subjacent tissue becoming pulpy, and separating when touched from the woody parts beneath. The whole soon dries up, and in many instances exhibits in the centre the black, irregular fungoid masses which are known under the name of *Sclerotium varium*, and which are believed to be the mycelium of certain moulds in a high state of condensation.

If the tubers are now examined, the greater part will often be found smaller than usual, especially if the disease has commenced at an early stage of growth; but in their natural condition, while here and there a tuber, particularly if it has been partially exposed, exhibits traces of disease. The surface is, however, soon marked with livid patches, commencing generally about the eyes, or at the point of connection with the fructifying shoots: these rapidly acquire a spotted appearance, the spots being rather waved, and assuming often a more or less concentric arrangement. Sometimes,—especially on the smoother kinds of tuber,—two or more regular systems of concentric spots are exhibited on the same tuber. The skin now withers, and is easily separated; the spots become depressed and of a yellowish tinge; and if the tubers be laid in a moist place, in a day or two—sometimes in a few hours—the same mould which destroyed the leaves springs from them, piercing the cuticle from within, yet not scattered, as on the leaves, but forming a conspicuous white tuft. If a section of the diseased tuber be made on the first symptoms of the disease, little brownish or rusty specks are found in the cellular tissue, confined, with very rare exceptions, to the space between the cuticle and the sac, if I may so call it, of spiral vessels and their accompanying tissue, which springing from the subterranean branches, pass into the tuber, making their way to the several buds disposed on the surface. These spots consist at first of a quantity of discoloured cells, mixed more or less with others in a healthy condition. The grains of fecula are for a long time perfectly healthy; the cells themselves, so far from being looser, are more closely bound together than in the more healthy portions. The rusty spots soon exhibit a darker tint, spreading in every direction and becoming confluent; they at length extend beyond the barrier of vascular tissue, and attack the central mass. The tuber, meanwhile, assumes a disagreeable smell, decomposes more or less rapidly, other Fungi establish themselves on the surface, or in the decaying mass, which emits a highly fetid odour, resembling that of decaying agarics, the union of

1.—Turnip Mould.
Peronospora parasitica.

2.—Onion Mould.
Peronospora destructor.



3.—Potato Mould.
Peronospora infestans.

4.—Lettuce Mould.
Peronospora ganglioniformis.

5.—Pea Mould.
Peronospora viciæ.

6.—Sandwort Mould.
Peronospora arenariæ.

MOULDS.

NATURAL HISTORY

the cells is dissolved, animalcules or mites make their appearance, till at last the whole becomes a loathsome mass of putrescence.

The form of the mould itself is represented (fig. 3) as exhibited under the microscope, with the nodose swellings of the branches and spores attached to the tips; these spores are filled with a granular mass, from which, as hereafter described, zoospores are produced. These spores are in themselves capable of reproducing the mould. The branching dendroidal threads of this fungus proceed from a creeping mycelium or spawn of entangled filaments which interpenetrates the matrix upon which it establishes itself. From these threads are also produced, though more rarely, a secondary kind of fruit, which is spherical and larger than the bodies borne on the tips of the threads. Under the name of *Artotrogus* this fructifying mycelium has been described as another species of fungus; but it is now admitted to be only a stage or condition of *Peronospora*. All the species of this genus noticed in this paper are subject to this condition, that is, under favourable circumstances, all are liable to produce secondary fruit from the myceloid filaments. This is not the only instance, even amongst the Fungi found upon the potato, of the same parasite under different phases having been regarded as a distinct species.

During the year 1861, Dr. de Bary published an account * of the discovery by him of a third mode of propagation in the potato mould, and that the most common of any. This method is by means of zoospores. The spores produced on the tips of the branchlets are certainly capable of germinating when placed in favourable conditions; but, according to M. de Bary, important changes more frequently take place in the granular matter with which they are filled, and bodies resembling small Infusoria are produced, which move about actively by means of two long filaments. These active zoospores, or insect-like bodies, are by no means restricted to the potato mould, but have long since been met with in many of the lower cryptogams. As a result of this method, and the rapidity with which the zoospores attain perfection, the number of agents for the propagation of the disease, produced in one season, seems almost past belief. De Bary calculates that one square line of the under surface of the leaves is capable of producing 3,270 spores, each of which yields at least six zoospores, sometimes double that number; thus we have 19,620 reproductive bodies from that small space. The mycelium from the zoospores is capable of penetrating the cellular tissue in twelve hours, and when established there, it bursts through the stomata of the

* Die gegenwartig herrschende Kartoffelkrankheit, ihre Ursache und ihre Verhutung. Von Dr. A. de Bary. Leipsig, 1861.

leaves, and fruit is perfected in from fifteen to eighteen hours. Since the zoospores are perfected and ready to germinate in twenty-four hours from their being placed in water it becomes almost impossible to calculate the myriads of fungi that may be produced from a single centre. Dr. de Bary has also demonstrated that the brown spots so characteristic of the disease are a result of the action of the spores or zoospores. By placing a quantity of spores in a drop of water on the leaves, stems, and tubers under a glass sufficiently air-tight to prevent evaporation, he produced the brown spots, and traced their progress from the earliest stages.

There are a few practical conclusions which may be drawn from these discoveries. In the first place, it is clearly shown by the production of the spots that the fungus is capable of *causing* the disease, a fact which has been disputed, but now placed beyond doubt. The inference is, that not only is it capable of producing, but is really the cause of the potato murrain. With bodies so minute and active as the zoospores, there can no longer be difficulty in accounting for their penetrating the tissues of the plant. They are most active and productive in wet weather, especially when it is also warm. Moisture appears to be essential, and a dry season the greatest enemy to the spread of the disease. That bodies so minute and subtle should have baffled all efforts to destroy or eradicate, is not now surprising. Whether any method will be found to contend successfully with it, is now more doubtful than ever. A careful re-perusal of the old facts by the aid of this new light will tend to the elucidation of much of the mystery in which the subject has been involved. All who have hitherto been sceptical of the mycological source of one of the greatest pests of modern times, should study M. de Bary's pamphlet.

It will be sufficient for our present purpose to state that one of the six families into which Fungi are divided for scientific purposes is called *Hyphomycetes*, a name compounded of two Greek words signifying "thread" and "mould" or "fungus," and is applied to this group because the thread-like filaments of which they are largely composed is the most prominent feature. In this family there are again a number of smaller groups called orders, having an equal value to the natural orders of flowering plants; and one of these orders called *Mucedines* has the fertile threads perfectly distinct from the mycelium or spawn. These threads are sometimes simple and sometimes branched, they may be articulated or without articulations or septa, short or long, erect or creeping, hyaline or whitish, mostly free from colour, and are not coated with a distinct membrane. The spores are generally simple, some-

times solitary, at others in pairs or strung together like beads for a necklace. Amongst all this variety of arrangement there is order, for these are but features or partly the features of the different genera of which the *Mucedines* are composed. One of the genera is termed *Peronospora*, and to this the parasitic fungus of the potato, and some others to which we shall have occasion to refer, belongs. In this genus the threads are generally branched but without articulations. The spores, or seed-like bodies, are of two kinds; one kind is borne on the tips of the branches; and the other kind, which is larger and globose, is borne upon the creeping mycelium or spawn. All the members of this genus with which we are acquainted are parasitic on living plants, inducing in them speedy decay, but preceding that decay of which they are themselves the cause. Hence we have deemed it the more advantageous course both for writer and reader to associate together the different species of this particular genus of parasitic moulds in the same paper, rather than bring together the different kinds of Fungi, belonging perhaps to widely separated genera, but all associated with, or parasitic upon, the same plant. The botanical student will thank us for following this plan, and the general reader will labour under no disadvantage, in this instance at least, from the similarity of the diseases produced in the plants infested.

The potato mould has been judiciously named *Peronospora infestans*, or, as it was at first called, *Botrytis infestans;* but on a revision of the genera *Botrytis* and *Peronospora*, it was transferred to the latter genus, in which it remains. Three names were given to it, within a short period of each other, by different mycologists, in ignorance of its having already received a name. The one we have adopted appears to have the priority, at least of publication, and was given by Dr. Montagne. That of *Botrytis devastatrix* was given by Madame Libert, and *Botrytis fallax* by M. Desmazières. The principal feature in this species seems to consist in the branches becoming alternately thickened and constricted, so as to resemble a moniliform string, or necklace of little bladders or vesicles. The branches are also more erect than in the allied species, and the spores are solitary on the tips or from the sides of the branches, and not in pairs or clusters, and the tips are simple, and not bifid or trifid, as in most of its allies. It need scarcely be remarked, that a high power of the microscope is necessary to make out the distinctive features of the different members of this genus, and that to the naked eye they only appear as a minute whitish mould. As already stated, this little fungus makes its first appearance on the under surface of the leaves, especially the lower ones, of the potato plant, and afterwards

attacks the stem, and ultimately the tuber. For examination, it is better to select the leaves soon after the fungus makes its appearance.

Turnip Mould.—Since the advent of the potato murrain a similar disease has been witnessed, though more limited in its extent, amongst Swedish turnips, commencing in little waved irregular lines following the course of the vessels, around which spots are formed by the deposition of dark granules, in the same manner as in the potato. In this instance, the leaves apparently are first attacked in a similar manner by a species of mould or *Peronospora* allied to the one already described, but which has been long known as parasitic upon cruciferous plants, to which the turnip belongs. This species, termed *Peronospora parasitica,* is white in all stages of its growth. It is much more branched, and the branches are comparatively shorter than in the potato mould, and the tips of the branches are bifid (fig. 1). The spores are very large and globose, features also which distinguish this mould from the last. A short time since we were called to witness a bed of splendid cauliflowers, which had, up to that time, been the pride of their cultivator; but, alas! their glory was threatened with speedy annihilation, for in nearly every instance the lower leaves had become more or less covered on their upper surface with yellow spots, and beneath, glaucous with the mould we have been describing. The diseased leaves were all immediately removed, but we fear without success, although no positive information has since reached us. The almost unnatural vigorous green of the leaves, prior to the appearance of the mould, is not at all an uncommon occurrence: this phenomenon has been noticed in the ears of corn, in which every grain was soon afterwards filled with spores of bunt.

Onion Mould.—Another disease, produced by Fungi of the same genus, has made its appearance upon young onion plants in the spring. The mould is called *Peronospora destructor,* and has many features in common with those already described. In this instance the threads are greyish and erect, with alternate branches, not divided by transverse septa, and the spores are obovate, attenuated towards their base (fig. 2). This mould, in some years, is very common and destructive, by preventing the young plants which are attacked from coming to perfection. It is not confined to the onion, but appears on other allied species of *Allium* (to which the onion belongs). The threads form large patches or blotches on the leaves, and sometimes cover them entirely. It very much resembles the turnip mould, from which the form of the spores considerably differs. Doubtless this, as well as all the other species of mould alluded to in this paper, are most common and destructive in

wet seasons. When the spring or summer is unusually dry, it is even difficult to meet with specimens for botanical purposes.

Lettuce Mould.—A very similar mould (*Peronospora ganglioniformis*) is sometimes very common in spring on the under surface of the leaves of the cultivated lettuce, appearing in definite white mouldy spots. By reference to the figure of a portion of a thread magnified (fig. 4), it will be seen that the peculiar form of the tips of the branchlets evidence the distinctness of this species.

Tare Mould.—The under surface of the leaves of tares, and sometimes also of peas, are liable to attack from an allied species of mould (*Peronospora Viciæ*). In the spring of 1846 it appeared amongst vetches in some districts to such an extent, as at one time to threaten the destruction of the crops; but a succession of dry weather at once abridged its power and limited its mischief. Mouldy vetches and mouldy peas are, especially in moist seasons, evils to which the agriculturist knows his crops to be subject; he may not know, however, that this kind of mould is of so near a kin to that which has acquired such wide-spread fame in connection with the potato (fig. 5). Another species of fungus attacks the garden pea in damp seasons, forming small depressed brownish spots on the leaves and pods; but this is quite distinct from the mould, though probably not less injurious.

The Parsnip Mould (*Peronospora macrospora*) is found on many umbelliferous plants; but its attacks upon the parsnip are most to be deplored, because it injures and ultimately destroys an article of human food. The plants infested with this parasite are first attacked in the leaves, but afterwards the roots become spotted and diseased in a similar manner to the potatos attacked by its congener. The disease has not hitherto been so general with the former as the latter; but in some districts it has been far from uncommon.

Spinach Mould.—Spinach is likewise liable to suffer from the establishment of a mould upon the under surface of the leaves: unfortunately this is not unfrequent, and has been known in England certainly for the last fifty or sixty years, since it was figured by Sowerby in his "British Fungi" as many years since. We have lately seen a bed of spinach utterly destroyed by this fungus; whilst on another, not twenty yards apart, not a spotted leaf could be found. This mould is of a pale purplish-grey colour, and has large oval spores. It is the *Peronospora effusa* of botanists.

Hitherto all the species of mould to which we have had occasion to refer have been found infesting plants more or less employed as food; but there remains one other species to which we must make special reference, and which affects one

of the most universal of favourites amongst flowers: this is the rose mould. Attention was directed to this mould, and it was described for the first time under the name of *Peronospora sparsa*, in the columns of the *Gardener's Chronicle*, in 1862. It occurred on a quantity of potted rose plants in a conservatory. Irregular pale brownish discoloured spots appeared on the upper surface of the leaves; these extended rapidly, and in a short time the leaves withered and shrivelled up, and ultimately the whole plant perished. A delicate greyish mould was to be seen by the aid of a lens, scattered over the under surface of the leaves. By the microscope, the branched threads, having the tips furnished with sub-elliptic spores, were revealed, and an ally of the potato mould found revelling amongst the roses.

Of the remaining British species, one (*P. Arenariæ*), is found on the leaves of the three-veined sandwort (fig. 6), another attacks the red corn poppy, a third is found on the common nettle, one on the brooklime, another on the wood-anemone, and another on the figwort.

Doubtless all the species in this genus are possessed of the third means of reproduction, by zoospores, as discovered in the potato mould. The fearful rapidity with which this method enables them to multiply themselves may account for their widely spreading and devastating power. No other genus of Fungi can parallel this in the number of species injurious to the field or the garden, or in which the injuries inflicted are so great and irremediable.

EXPLANATION OF PLATE.

Fig. 1. Beaded Brand (*Xenodochus carbonarius*), from the leaf of the burnet. Greatly magnified.

„ 2. Burnet Brand (*Aregma acuminatum*), on the three upper leaflets of *Poterium sanguisorba*, with the yellow sori of the Burnet Rust (*Lecythea Poterii*) on the lower leaflet.

„ 3. Spores of the Burnet Rust (*Lecythea Poterii*).

„ 4. Spore of Burnet Brand (*Aregma acuminatum*).

„ 5. Strawberry Brand (*Aregma obtusatum*), and Strawberry Rust (*Lecythea Potentillarum*), intermixed on leaf of *Potentilla fragariastrum*.

„ 6. Spores of the Strawberry Rust (*Lecythea Potentillarum*).

„ 7. Spore of Strawberry Brand (*Aregma obtusatum*).

„ 8. Rose Brand (*Aregma mucronatum*), and Rose Rust (*Lecythea Rosæ*), on leaflet of cultivated rose, intermixed.

„ 9. Spore of Rose Rust (*Lecythea Rosæ*).

„ 10. Spore of Rose Brand (*Aregma mucronatum*).

„ 11. Bramble Brand (*Aregma bulbosum*) and Bramble-rust (*Lecythea Ruborum*), intermixed on leaflet of bramble.

Fig. 12. Spores of Bramble Rust (*Lecythea Ruborum*).
„ 13. Spore of Bramble-brand (*Aregma bulbosum*).
„ 14. Spore of the same burst, with the inner cell escaping.
„ 15. Spore of *Aregma bulbosum* in germination, with globular orange sporidia produced at the extremities (*after Currey*).
„ 16. Tuft of spores of *Aregma*, showing the manner in which they are clustered together. Magnified.
„ 17. Meadow-sweet Brand (*Triphragmium Ulmariæ*), on portion of leaflet of *Spiræa ulmaria*.
„ 18. Trilocular spores of *Triphragmium Ulmariæ*.
„ 19. Spore of *Triphragmium Ulmariæ* in germination, bearing secondary fruit (*Tulasne*).
„ 20. Corn Mildew (*Puccinia graminis*) on a piece of wheat straw.
„ 21. Portion of a section of straw, showing a tuft of Mildew (*Puccinia graminis*) *in situ*.
„ 22. Spore of Corn Mildew (*Puccinia Graminis*).
„ 23. Coronated Brand (*Puccinia coronata*), on a portion of grass leaf.
„ 24. The same enlarged, showing the sori.
„ 25. Spore of Coronated Brand (*Puccinia coronata*).
„ 26. Thistle Brand (*Puccinia syngenesiarum*), on portion of leaf of spear-thistle (*Carduus lanceolatus*) showing the compound pustules.
„ 27. Spores of the same.
„ 28. Anemone Brand (*Puccinia Anemones*), on leaf of wood anemone (*Anemone nemorosa*).
„ 29. Echinulate spore of Anemone Brand (*Puccinia Anemones*).
„ 30. Centaury Brand (*Puccinia Compositarum*), on leaf of knapweed (*Centaurea nigra*).
„ 31. Spores of the same.
„ 32. Mint Brand (*Puccinia Menthæ*), on leaf of corn-mint (*Mentha arvensis*).
„ 33. Spores of the same.
„ 34. Earth-nut Brand (*Puccinia Umbelliferarum*), on leaf-stalks and leaf of earth-nut (*Bunium flexuosum*).
„ 35. Spores of the same.
„ 36. Ground-ivy Brand (*Puccinia Glechomatis*), on leaf of ground-ivy (*Glechoma hederacea*).
„ 37. Pustule or sorus of *Puccinia*, girt by the remains of the ruptured epidermis.
„ 38. Spores of *Puccinia glechomatis*.
„ 39. Dandelion Brand (*Puccinia variabilis*), on portion of leaf of dandelion (*Taraxacum Dens-leonis*).
„ 40 Variable spores of the same.

*** All the spores are more or less magnified.

NOTES ON EARTHQUAKES.

BY REV. W. S. SYMONDS, RECTOR OF PENDOCK.

IT was very generally believed, only a few years ago, that the earth was not more than about six thousand years old. Astronomers and geologists have, however, ascertained, beyond a doubt, that the planet we inhabit has not only been rolling in space for untold ages, but has undergone numerous physical changes. They also believed that this planet was once in a condition of complete fluidity, and almost up to the present time they considered the principal portion of the interior of the earth to be composed of mineral substances liquefied by intensity of heat. Of late, the labours of mathematical investigators have gone far to prove that the central nucleus of the earth is *not* altogether composed of molten mineral substances, so as to form a central igneous ocean, but that lakes or small seas of lava are distributed throughout her mass. Whatever truth there may be in this theory, it is to *natural causes* that we must look for the explanation of the phenomenon of the earthquake, that agent which has played so important a part in again and again remodelling the surface of the earth.

From numerous observations made in deep mines, it is found that the temperature of the earth increases as we descend at the rate of 1° of Fahrenheit for every fifty or sixty feet after the first hundred. The phenomena of hot springs, and the emission of vast masses of molten mineral matter, volcanic ashes, mud, &c., from volcanos, with calculations founded on the known specific gravity of the earth, all tend to convince scientific men that the earth possesses a high internal temperature which is derived from *internal sources*.

It is impossible to read the description given by Sir Charles Lyell of the phenomena of earthquakes and volcanos without being satisfied that both of these agents have, to a certain extent, a common origin; but it is also certain that there are two modes of action in earthquake forces of disturbance—viz., when they act with local intensity, as in volcanic action, or by a succession of earthquakes, as in the elevation of the coast of

Chili in 1822 and 1823; and when they act uniformly, and lift up large tracts of land, as the coast of Sweden is now being raised, with a slow and tranquil, upward movement; and the west coast of Greenland depressed, without any of those paroxysmal effects which we behold in the volcano, and the earthquake shock.

No less than five centres of volcanic action exist within the Atlantic Ocean. In Europe, the centres of existing volcanic action are Sicily, Naples, Stromboli, the Archipelago, and Iceland; while in Auvergne, Bohemia, Saxony, and other European localities, we have examples of volcanos which have become extinct since the period of the older Tertiary deposits. In the region of the Andes active and extinct volcanos alternate for many hundreds of miles, and tremendous earthquakes frequently precede the different outbursts. Five active volcanos traverse Mexico from west to east, among which is the famed Jorullo, which is said to have been elevated to a height of 1,600 feet above the level of the plain of the Malpais in June, 1759. There is an active volcanic region from the Aleutian Isles, through the Indian Archipelago, of greater extent than even that of the Andes. In Java alone there are said to be thirty-eight volcanos, several of which are more than 10,000 feet high; while Berapi, in Sumatra, is more than 12,000 feet above the sea. Teneriffe is also 12,000 feet, and Etna nearly 11,000 feet in height.

To enumerate the different volcanic regions of the globe would be impossible in a mere sketch of the subject, and it must suffice here to say that several hundreds of volcanos, in different stages of activity, are known throughout the globe.

The *effect* of volcanic eruptions in those regions which are the centres of volcanic action is scarcely less important as regards human life and safety than are earthquakes. The destruction of the cities of Herculaneum and Pompeii by vast masses of volcanic matter erupted from Vesuvius is an example; as are also the overwhelming of the town of Stabiæ in the time of Pliny, and the destruction of the town of Torre del Greco by torrents of burning lava in 1794. But these are not the most striking examples of volcanic eruptions to be met with. The volcano Coseguina, which is situated on the Gulf of Fonseca, in Central America, poured forth, in January, 1835, such a mass of volcanic ashes and other matter that it covered the surrounding country for the distance of twenty-five miles to the depth of ten feet, destroying the woods and dwellings. Sir Charles Lyell records of this eruption, that thousands of cattle perished, their bodies being, in many instances, one mass of scorched flesh; that many birds and wild animals were found suffocated in the ashes; and that the neighbouring

streams were strewed with dead fish. This great eruption of Coseguina was accompanied by an earthquake which was felt over more than one thousand miles, the volcano having been dormant for twenty-six years.

"Moya," or volcanic mud, which is composed of ashes and liquefied snow, descended, in 1797, from Tunguaragua, one of the Quito volcanos, and filled valleys six hundred feet deep, a thousand feet wide, and many miles in length, with a pulpy material, which dammed up rivers and caused lakes.

The eruption of Skaptar Jokul, in Iceland, in 1783, destroyed no less than twenty villages, and caused the death of no less than nine thousand human beings out of a population which did not exceed fifty thousand, together with an immense number of cattle. Professor Bischoff has calculated that the mass of lava brought up from the subterranean regions by this single eruption surpassed in magnitude the bulk of Mont Blanc. At all events, there were erupted two enormous streams of lava, which flowed in nearly opposite directions, one of which was fifty miles long, and from twelve to fifteen miles in breadth, and the other forty miles in length by seven in width. The elastic forces that eject these vast masses of volcanic materials from volcanic vents must be very great. The crater of Cotopaxi is more than three miles and a half above the sea, yet it has been known to eject a mass containing more than a hundred solid yards of rock to a distance of nine miles; and it has been calculated that a column of lava one foot square, raised to the height of Cotopaxi, would weigh more than seven hundred and fifty tons.

We have also evidence that volcanic eruptions into the sea, through fissures in the sea-bed, are by no means uncommon, though we have little opportunity of judging of their effects. Islands have been raised by volcanic elevation within the historical period, such as the island in the Aleutian group, described by Langsdorff, 3,000 feet high, and which was elevated in 1793. In the same year an island rose in the Azores; it was about a mile in circumference, and about 300 feet above the level of the sea. It was composed of volcanic ashes and other light materials, and was soon washed away by the sea. Santarino, White Island, New Burnt Island, and several other islets in the Grecian Archipelago, are all due to submarine volcanic agency, and their elevation above the waters is recorded in authentic history. There are also numerous instances on record where the commanders of vessels have noted submarine eruptions, as evidenced by the escape of gases, and the destruction of marine animals.

The intimate manner in which great earthquake shocks are connected with volcanic phenomena, makes the subject of any

direct evidence of volcanic action in the British Isles an interesting question. There is geological proof that in the earlier ages of the planet's history Great Britain possessed her active volcanos, and must have been shaken by earthquakes of terrible potency.

When the rocks that constitute the mass of Snowdon were being deposited in the seas of the Lower Silurian epoch there must have been an active volcano near at hand, for there we have marine deposits, full of the remains of animals which lived in the Llandeilo and Caradoc periods, interstratified with felspathic ashes, traps, and porphyries which no doubt were erupted from a volcano into the air, and then fell and sank through the waves.

Every geologist who visits Edinburgh must be struck with the evidences of volcanic action, which must have been rife in that district during the Carboniferous period, and volcanic action combined with the stratifying operations of sea-waves and currents.

Limestone of the age of the Lias has been converted by a Plutonic rock into crystalline marble in the Isle of Skye; and the basaltic columns of the Giant's Causeway in Ireland, and the Isle of Staffa, are currents of lava which are of later date than the chalk, and probably were contemporaneous with some of the lavas of Central France and the Rhine.

There are two curious notices, brought forward by Dr. Thomas Wright, in the Miscellanea of the *Athenæum* of November 28th, respecting instances of *recent* volcanic action in the British Isles. He informs us that Adam de Marisco, a friend of Simon de Montfort, and an English scholar of the thirteenth century, has recorded a volcanic eruption in the Channel Islands as occurring in his time (about the middle of that century); and also that the "Annual Register" for 1773 contains a notice of the eruption of "liquid fire" and "vast bodies of combustible matter" from Moel Famma, a hill on the borders of North Wales, on the 31st of January of the same year. These records are probably more singular than true; for in the case of Moel Famma no volcanic rock of any kind is marked by the geological surveyors on the hill, or in the district, and it is extremely unlikely that these accurate observers would have passed by relics of the "liquid fire."

Some geologists have argued that the phenomenon of volcanic action was far more developed in the early ages of the earth's history than at present, but further investigations into the philosophy of the subject throw more than a doubt on the truth of this theory. This constant earthquake and volcanic doctrine was invented to account for the earth tempests and continual blowing up of the earth's crust, which were supposed

to be rife during the consolidation of a cooling planet. But the evidence which was believed to support this theory of the development of our planet breaks down on a calm investigation of facts. *We ignore the volcanic forces that still exist!* What lakes or sea of lava must underlie the volcanic districts of the Andes and Indian Archipelago at the present moment, and what masses of molten matter, which never appears at the surface, must be injected every year, in earthquake districts, into rock fissures, or into the beds of the different seas. Volanic action, with its evidence of the earthquake, and great outpourings of traps, lavas, and other materials, has left its undoubted marks throughout the Cambrian, Silurian, Carboniferous, and every other geological period; but the Plutonic masses that have been erupted from the interior of the earth, and the earthquake movements which are known to have occurred *since the commencement of the Tertiary periods*, have been enormous, and may well cause us to pause ere we assign to any geological period in particular the peculiarity of an "earthquake age."

I have made the preceding remarks upon *direct volcanic action*, because intensity of earthquake action appears to be connected with volcanos and their effects. Indeed, Mr. Mallet, who is the highest authority upon the subject, believes that "an earthquake, in a non-volcanic region, may be viewed as an uncompleted effort to establish a volcano." Questions have arisen as to whether *all* earthquakes are produced by volcanic action, and an ingenious problem has been broached by Mr. Mackie, the editor of "The Geologist," in the November number of that periodical, as to "whether some earthquakes may not be due to *the crystallization of rock masses* under the pressure of superincumbent strata, and that they are 'the shocks' of the rupture of masses of dense strata, or the sudden slippings of one great rock formation over another." This theory of Mr. Mackie's brought forth a letter from Mr. Scrope, which is published in the December number of "The Geologist," who refers earthquakes of all kinds to the same primary cause as the volcanic eruption; and thinks it quite "unnecessary to resort to any other, such as terrestrial electricity, magnetism, crystallization, the breaking in of the roofs of imaginary subterranean cavities, or the condensation of vapour evolved from submarine volcanoes." In this supposition I entirely agree with Mr. Scope, and believe that it is altogether unnecessary to resort to imaginary hypotheses to explain those phenomena which are accounted for by so many examples and recorded facts. I do not conceive that we have any evidence whatever to suppose that "snaps and jars," or earthquakes of any kind, are independent of volcanic

phenomena, while we have so much evidence the other way. There is a motion of the earth's crust which lifts and depresses enormous tracts of land, and which, as far as we know, acts equably and without paroxysmal violence; but these movements, however equable, must always be accompanied by occasional "snaps and jars," and the rending of the rocks in the interior of the earth. In short, the frequent occurrence of earthquakes such as we have lately experienced in England, is what, as geologists, we must expect, from our knowledge of volcanic phenomena, and the oscillatory movements of the crust of the globe which have happened throughout all geological time.

It is not, happily, in England that we experience much of earthquakes and their effects. It is in volcanic regions that severe earthquakes occur, and there the imagination can picture nothing more awful than their results. Mr. Mallet and M. Perrey, of Dijon, have catalogued systematically the different accounts of earthquake phenomena, and it has been calculated that several millions of human beings have been destroyed by earthquakes within the last four thousand years. Whether they occur along the line of the Andes, in the Indian Archipelago, in Sicily, or in Portugal, "misericordia!" is the cry, and fearful indeed are the devastations which are witnessed by the survivors of such catastrophes.

Two hundred and fifty thousand persons were killed at the first earthquake of Antioch in the year 526, and sixty thousand during the second catastrophe, seventy-six years afterwards. In 1797, forty thousand persons perished from earthquakes in Quito. Sir Charles Lyell records that one hundred thousand people were killed by the Sicilian earthquakes of 1693, when the city of Catania and forty-nine other villages were levelled to the ground; and it was ascertained that sixty thousand persons were destroyed in the course of six minutes, during the earthquake of Lisbon in 1755.

One account of the effect of a severe earthquake which happened as lately as 1861 will suffice as an example of the occasional effect of such catastrophes on human life and human welfare. The following is the record of Major Rickards of the destruction of the city of Mendoza, in South America. He says:—

> I was absolutely struck dumb and immovable with horror at the scene which presented itself! I gazed along the whole length of a street; not a single house was there to be seen standing; all was a confused mass of "adobes," beams, and bricks! The street was filled up on a level with what remained of the walls of the houses on either side, which at a glance accounted for the fearful number of victims—upwards of 12,000 out of a population of 16,000—entombed beneath the ruins on that fatal 20th of

March, 1861. Nothing met my eye but desolation and ruins. For a mile around, on every side, nothing but a chaotic mass of destruction was visible, the *débris* of a large city razed to the ground in an instant. On approaching the Church of Santo Domingo, I saw lying about its precincts human skeletons and portions of the human form protruding from beneath the masonry. In many parts of the city I saw the same horrible exhibition—skulls, arms, legs, &c., lying about, some still undecayed. At last I retired to my quarters, meditating upon the dreadful catastrophe which had in a few seconds turned a gay and beautiful city into an enormous graveyard.

As late as June last, more than one thousand persons were killed, and many thousands injured, by an earthquake which destroyed in a moment the town of Manilla. In volcanic districts, moreover, we learn that those paroxysmal earthquakes occur by which whole districts of land are permanently elevated or depressed; and *these effects* of earthquakes should be especially noted. In Chili, three hundred shocks of earthquakes were counted between 20th of February and the 4th of March, 1835, and the coast was permanently elevated. Admiral Fitzroy found beds of mussels, chitons, and limpets in a putrid state, but still adhering to the rocks, and raised ten feet above high-water mark. Mr. Darwin found similar shells at Valparaiso, at the height of 1,300 feet, and had no doubt that those shell-beds were elevated to their present position by a series of earthquake shocks which caused successive small uprisings. On the 19th of November, 1822, a most destructive earthquake occurred on the coast of Chili, the shock of which was felt throughout a space of 1,200 miles from north to south, and an extent of country was elevated which was calculated to equal half the area of France. A similar history of upraised shells, sea-weeds, and other marine remains, was recorded at the time by Mrs. Graham. Sir Charles Lyell's celebrated proofs of the elevation and subsidence of the coast of the Bay of Baiæ, and that the relative level of land and sea has there changed *twice* since the Christian era, are too well known to need description. As an example of a *more recent* elevation of the earth's crust, we may mention the instance brought forward by Sir Charles Lyell, in a Lecture delivered before the Royal Institution in 1856. It occurred in the previous year (1855) in New Zealand, simultaneously with a very severe earthquake; and an elevation of upwards of five feet, on the north side of Cook's Straits, affected the tide of the river Hutt to such an extent that it was almost excluded; while a depression on the other side of Cook's Straits caused the tides to flow up the river Wairua many miles higher than before the alteration of the land level by the earthquake. A regular "fault" was also exposed to view for the instruction of

geologists, for a shift in the rock surface took place, and a "step" of rock, nine feet high, was raised for a distance of ninety miles.

With regard to the *depression* of land by earthquakes, we may instance the large tract known as "The Sunk Country," at New Madrid, Missouri, which was submerged by earthquakes in 1811 and 1812. This depressed tract extends along the course of the White Water river for a distance of between seventy and eighty miles north and south, and for thirty miles east and west. The earthquake of Cutch, in 1819, caused a subsidence of land in one part of the delta of the Indus, and an elevation in another. In Sicily, in 1790, the ground at Maria di Niscemi, on the south coast, sank down in one place to the depth of thirty feet; while, during the tremendous Lisbon earthquake of 1755, the new quay, which was built entirely of marble, sank down to the depth of six hundred feet, carrying with it a great number of boats and small vessels, as well as a large number of persons who had fled there for safety. The effects of paroxysmal earthquakes in volcanic districts are so well known, and have been so often related, as to require no further description here.

There is, however, another motion of the earth's crust which lifts and depresses whole continents, without any violent earthquake movements. We know very little respecting these great elevating and subsiding movements. Mr. Darwin believes, from the intimate and complicated manner in which the elevatory and eruptive forces are connected with volcanic phenomena, we may confidently come to the conclusion that the forces which at successive periods pour forth volcanic matter are identical with those forces which, slowly, and by little starts, uplift continents. Again, Sir Charles Lyell, in his "Antiquity of Man," remarks, that from what we do know of the state of the earth's interior, we must expect that the gradual expansion or contraction of different portions of the planet's crust may be the result of changes and fluctuations in temperature, with which the existence of hundreds of active, and thousands of extinct volcanos, is probably connected. There are large portions of the earth's surface which have been elevated above the level of the ocean in Africa, in the north of Europe, South America, and other parts of the world, which bear no signs of paroxysmal upheaval, of volcanic overflows, or of any other than extremely equable movements. Sir Roderick Murchison informs us, that there are in Russia large areas, consisting of rocks of the age of the Lower Silurian deposits, which have been but partially hardened since they were accumulated, which have never been penetrated by volcanic matter, and have undergone no great change, or disruption, during the enormous periods which

have elapsed since their deposition in the bed of the Silurian seas.

It has been proved beyond a doubt, that the land in Sweden and Norway is gradually being elevated out of the sea; and Mr. Lamont, in his "Seasons with the Sea-Horses," furnishes us with some remarkable evidence of the rapid elevation of the land around Spitzbergen, even the sealers remarking that "the sea is going back."

But we do not need to journey to Norway or Spitzbergen for proofs of the elevation of land. Great Britain has been elevated to an extent incredible to those who have not studied the subject, since the period of existing shells. The study of the drift and gravel deposits of this country will convince any geologist that by far the larger portion of Great Britain has emerged from the sea since the commencement of the glacial period, and that its emergence was extremely gradual and slow. I have myself seen numerous instances where stratified sand banks, and loose gravel and shingle, occupy elevated positions in Scotland, England, and Wales, and of which the appearance at once forbids the conclusion that they were hoisted up to their present position by any sudden paroxysmal motion, or by any other action than a series of small successive uprisings, and the gradual, equable motion I have alluded to. As examples of these elevated marine gravels and drifts, I may mention one on Moel Tryfane, near Carnarvon, which occupies the summit of a hill platform, at a height of nearly 1,400 feet above the sea. I had the pleasure of visiting this ancient and remarkable raised beach last summer, in company with Sir Charles Lyell, and of gathering some of its characteristic shells from among the loose sand, shingle, and pebbles, which are there elevated to this extraordinary height. There is another instance, but not of so striking a character, between Shrewsbury and Bridgnorth, on the Severn, where Mr. George Maw discovered great quantities of marine shells, some of boreal character, in drifts which are elevated a hundred, or a hundred and fifty feet above the Severn. These are instances in our own country which any naturalist may study for himself.

But we have upheavals of a later date than those just instanced, and which have no doubt occurred since the occupation of England by man. Flint weapons have been found near Bedford, and other localities, which prove that England was inhabited by an ancient people, who lived in ages long remote, and before the country had been upheaved to its present position. These beds are probably correlative in age to the celebrated drifts containing human tools in the Somme valley. Many caves containing human remains, associated

with those of extinct animals, have been greatly altered in position, and upheaved since the deposition of the organic remains, while ancient land surfaces have in other parts subsided beneath the sea. Ancient canoes have been found near Glasgow, in upheaved marine silts; and we are informed by Sir Charles Lyell, that "at the time when these ancient vessels were navigating the waters where the city of Glasgow now stands, the whole of the low lands which bordered the present estuary of the Clyde, formed the bed of a shallow sea." This emergence is proved to have been gradual and intermittent.

On the east and west coasts of Scotland there are raised beaches of from twenty-five to forty feet in height above high-water mark; and it appears probable that the coast-line in the neighbourhood of Edinburgh, has changed since the human epoch. At all events, it has altered considerably within a recent geological period.* Mr. Geikie believes that an elevation of other parts of the Scottish coast-line has occurred since the Roman occupation of the Roman stations on the Solway, the Forth, and the Clyde. This presumption is still doubtful, but my own observations and inquiries induce me to believe that Mr. Geikie is right. We have then a good deal of evidence to prove that oscillatory movements have occurred in England, to a very considerable extent, up to a late period; and I believe that such movements should be attributed to a succession of small earthquakes, such as the late shock so generally experienced throughout England, or those shocks which destroyed the cathedral of Lincoln in 1185, and many of the largest churches in England in September, 1275. I say, a succession of *small earthquakes*, for we have no evidence of the overflow of volcanic matter, or of paroxysmal earthquakes, such as those which happen in volcanic countries, for a very long period.

With regard to the late earthquake, it had every appearance of being one of those sensible vibratory undulations of the earth's surface, referred by Mr. Scrope "to the snap and jar occasioned by a sudden and violent rupture of rock masses at a greater or less depth, and probably the instantaneous injection into the fissures so formed of intumescent molten matter from beneath." It certainly seems only reasonable, when we reflect that the British Islands are on the line of the volcanic belt which affected Portugal when Lisbon and several other cities were nearly destroyed, and which reaches to the Canary Islands, to refer our British earthquakes to the same cause as volcanic eruptions, namely, *pent-up subterranean heat*. We

* See "Edinburgh and its Neighbourhood," a work by the late Hugh Miller, just published.

know that subterranean heat exists to an enormous extent in the interior of the earth, and in former ages has melted and erupted masses of fluid rock, and caused subsidences and elevations here in England, and, in all probability, will do so again. Why seek for other and unknown causes? The earthquake of October last was harmless, but it was sufficiently violent in some localities to make us understand that the powers are not extinct, and that volcanic agency is not dead beneath us. A shock of only double the violence would probably have caused some serious catastrophes in the neighbourhood of Ross and Abergavenny. The direction of this earthquake appears to have been from south-west to north-east. This is believed by Mr. Mallet to be the line of the Lisbon earthquake; and it was certainly the line of many earthquake movements in former ages. During the earthquake at Lisbon, Loch Lomond rose two or three feet; women washing in the Tay were swept off their legs by a wave; and a great wave rolled into Kinsale. In Carmarthen Bay, about eight hours after the earthquake of October, a large body of water, of a dark-brown colour, as if charged with earthy matter, was seen to roll forward in the shape of a cone, and coming in contact with a boat, "the boat was violently pitched about, and the water thrown completely over it."

The roaring noise which accompanied the earthquake is supposed, by the editor of "The Geologist," to have been "fancied." And the phenomena that occurred are treated so lightly, that it is manifest Londoners heard and felt very little in comparison with those who reside in the western counties. The evidence of the Rev. H. C. Key, of Stretton Rectory, near Hereford, with respect to the noise, which he likens to that of "a very heavy and long train rushing furiously through a station," is precisely the evidence that I have received from several other persons who happened to be awake, and who never heard or read of Mr. Key's experiences.

As regards the undulatory motion of this earthquake, and the boat-like rocking which has been described by some persons, I may say that in four instances where I examined the position of their beds, I found that their broadsides lay east and west, or nearly so. In cases where the heads of the beds lay north or south, the swaying motion from side to side does not appear to have been experienced to a similar extent. The localities where the shock was felt most appear to have been along the line of certain rivers in the West of England which run along the track of ancient earth movements. The Golden Valley, in Herefordshire, along the banks of the Dore, was much shaken, as also were the valleys of the Wye, and certain tributaries of that river towards Monmouth and Abergavenny.

At Llancilio, the seat of Colonel Clifford, M.P., a fissure was caused in a wall, and some prints just pasted down were split across. Llancilio is not far distant from an example of the effects of ancient earthquakes; for, at Usk, a large dome of Upper Silurian rocks is upcast through the surrounding and overlying Old Red Sandstone of the district. At Ashfield, near Ross, on the Wye, the walls of two unfinished houses were partly thrown down; and at Bishop's Wood, below Ross, a line of former faulting and rending of the earth's crust, a house standing close on the river was so much heaved and rocked that the occupant of a heavy old four-poster bed was nearly thrown out. The noise here was as loud as in the neighbourhood of Hereford, for the gentleman who rested in the bed supposed that an explosion of gunpowder had taken place in a barge on the Wye, and he rushed to the window. The following evidence from the Ross neighbourhood of the external phenomena attending the shock, is rather remarkable. I received the information from a friend, who is thoroughly to be depended on. A man rose unusually early, and was engaged in loading a cart with potatoes, which he had promised to deliver before his day's work commenced; when, on a sudden, "he heard a dreadful noise come roaring up," apparently from a wood to the westward, and his cart rocked so violently that he was nearly thrown out of it. The trees all around him rocked violently to and fro, and the rooks arose cawing from the wood; the small birds also twittered, and took wing with notes of distress. The thunder-like noise appeared to roll off towards the east.

I might give numerous other instances of the effects of the October earthquake in the West of England, but I think enough has been said to prove that it was a very different affair from the London experiences of "three little quivers," and "legs which were asleep and twitched." Here it was a severe shock for Great Britain, and confirms our opinion more and more that the volcanic doctrine is the true one, whatever may be the truth of the existence of a Plutonic nucleus in the interior of the planet. There is no doubt, however, that there is a good deal in the remark, that the variety of sensations, and the degrees of violence, in different localities were owing to the variations of geological conditions, and the medium of solid rock, or looser strata, which communicated the earth-wave from place to place.

Finally, the question of principal importance is, whether we are to expect a renewal of such phenomena from time to time, and whether it is possible that volcanic fires and their companions, paroxysmal and violent earthquakes, may again agitate our native land. But this is a question it is impossible

to answer. We do not know why the fire of the volcano and the rending of the earthquake should become locally extinct at different geological periods, or why the centres of volcanic eruption should vary; but we know that they have formerly done so, and we do not doubt that they will thus vary again.

The volcano and the earthquake are some of the principal means which the great Creator employs for the construction and the adaptation of the planet on which we live; but *when* their forces are to be employed, or *where*, does not lie at present within the reach of man's philosophy.

REVIEWS.

THE NATURAL LAWS OF HUSBANDRY.*

IT is too true that men are apt to be led away by the assertions of others on whose judgment and intellectual capacity they rely; and since we very frequently find that those who are most dogmatic in their enunciation of certain views are exactly those who have given the subject connected with those views the least consideration, it results that they who put their trust in them, find, at the eleventh hour, that they have been lamentably deceived. So it is with the agriculturists of England. Being, as a rule, men who from their education, or rather from the entire absence of education, are incapable of conceiving an idea of anything in the abstract, are totally devoid of powers of generalization, and hence averse to all which borders on theory, they are easily carried away by any statement which emanates from what they delight in calling "practical men." This is no mere supposition. It is familiar to every one who has attempted to explain to the commonplace farmer, that his crops grow in obedience to certain fixed laws, and that they, like his cattle, must be fed with such a form of food as is best suited to their requirements, that a theoretical illustration of even the simplest class is uncongenial to an agriculturist's mind. This being the case, it follows that, if we desire to establish a better state of things in those countries, if we would raise the farmer (we do not allude to the country gentleman) from his present degraded condition, and if we would regard the future welfare of this country as of importance, then there is but one remedy—to educate the agriculturist to a thorough knowledge of the theory of his profession. This is what the great German baron has essayed to do; this is what he has toiled, during the last sixteen years, to achieve. The direct result of his labours is now before us, in the form of a work which, while rendered in a style of English intelligible to any person of ordinary education, is at the same time as accurately scientific as a thorough knowledge of present-day chemistry could accomplish, and as profoundly philosophic as any literary production of Baron Liebig's might be expected to be. The volume is divided into twelve chapters, and the whole subject is treated in a most comprehensive and, we should think, exhaustive manner. The first chapter relates to the physiology or life-history of the plant, and in it are discussed not only the chemical conditions of vegetable life, but also

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* "The Natural Laws of Husbandry." By JUSTUS VON LIEBIG. Edited by JOHN BLYTH, M.D., Professor of Chemistry in Queen's College, Cork. London: Walton & Maberly. 1863.

those which refer to the other modifications of universal force—heat and light. It is shown that, by the mutual co-operation of these various influences on the one hand, and the organized germ of the plant on the other, the latter eventually assumes its definitive form. Numerous experiments are cited to prove the doctrines laid down; and the author then proceeds to the subject of *radication*, or the nature and form of roots, which has hitherto been too much neglected, especially by our English agricultural chemists, who have fallen into serious errors that a thorough knowledge of botany would have enabled them to avoid. Stress is laid upon the fact that one class of plants obtains its food from the subsoil, while another derives it from the arable surface; the former being represented by the turnip, and the latter by the cereals. In Chapter II. we are treated to a history of soils, of their varied compositions, and their relations to the roots of plants. Here the author dwells upon the circumstance that soils possess the power of abstracting the mineral food of plants from its solution in either pure or carbonic acid water, and of then retaining it. It is shown, too, that a crop may fail from the absence in the soil of some one particular form of food, although the other necessary constituents may be present; and the reason why wheat may flourish on the same ground which refuses to grow rye, is given in the clearest manner. The third chapter embraces the description of the various classes of manure, their chemical and agricultural qualities, and the reasons why it is necessary to have a uniform distribution of the food-elements of manures. The more important feature of this portion of the text—indeed, we may almost say of the entire volume—is that, here, the errors of Messrs. Lawes and Gilbert are unsparingly exposed. Clover-sickness, as it is termed by farmers—to whom, by the way, its cause has always been an enigma—was taken in hand some years since by the two English chemists referred to. They made it their especial hobby, and trotted it out on every possible occasion, as one of their triumphs in the chemico-agricultural direction. It turns out, however, that their hypothesis is a sham, a wild speculation, unsupported by the results of experience, and, as Baron Liebig convincingly demonstrates, overthrown by the very experiments of its originators. Clover, the author shows, is one of those plants whose roots descend to considerably greater depths than others, and, in reality, obtains most of its nourishment from the subsoil. But this is not all. Owing to the small quantity of nutritious material which the seed contains, it is obliged, even in the early stages of its growth, to abstract food from the soil, and therefore it robs the arable surface as well as the deeper strata; and when its roots reach the subsoil, those of them which still lie in the upper layer become so suberous in character as to lose the power of removing mineral elements from the earth; hence in its later days it feeds upon the subsoil exclusively. It sometimes happens that a crop of clover which during winter looked remarkably well, becomes sickly as spring advances, and, in course of time, perishes entirely. This is what is designated clover sickness, and what Messrs. Lawes and Gilbert took upon themselves to explain; and this is their explanation:—Clover feeds upon organic matter of a complex kind, whilst cereals live upon minerals chiefly. Now, it is a most remarkable circumstance that these experimentalists, in operating upon two

soils under almost identical climatic conditions, found that the ground was *poisoned* for clover in one case, and not in the other. They also assert, that when land is clover-sick the *only* remedy is to wait some years before repeating red clover upon it. Baron Liebig, after carefully analyzing all their arguments, thus states the real cause of the failure of the clover on the approach of spring :—

"There cannot be the slightest doubt about the reason of this decay: the exhausted subsoil had not received back any of the lost conditions of fertility, and thus the plants were starved as soon as they had passed through the arable surface-soil, and their roots were beginning to spread in the subsoil."

That the soil is not inexhaustible, is shown by reference to the condition of certain soils once virgin, like those of parts of the American continent; and in regard to the ultimate result of all endeavours to enrich the soil by bringing the subsoil to the surface, the author writes :—

"The notion of our ignorant practical husbandmen, that the soil contains ample store of the elements of food to enable them to pursue their system of agriculture, is due partly to the excellent quality of the land, but also to their skill in robbing it. The man who attempts to gain money by filing the weight of one gold piece from a thousand, cannot plead, in extenuation, that it is remarked by no one; but, if discovered, he is punished by the law: for everybody knows that the fraudulent act, repeated a thousand times, would ultimately leave nothing of the gold pieces. A similar law, from which, moreover, there is no escape, punishes the agriculturist who would make us believe that he knows the exact store of available food-elements of his land, and how far it will go, and who deceives himself when he fancies he is enriching his field by bestowing on the arable surface-soil the matter taken from the deeper layers."

In another chapter we are shown, by reference to the experiments of Schoenbein (*vide* Popular Science Review for October, p. 108), that the ammonia of soils is derived from the atmosphere, and that all the factories in the world would not supply the quantity required, were it otherwise. To any one who reads Baron Liebig's work, the conviction is inevitable, that plants derive their mineral constituents from the soil, and their organic materials from the air; that the action of ammonia salts as manures is merely a solvent one; and that, in our country, we are every day robbing the earth of a quantity of inorganic salts which is never restored, and that, in consequence of this, serious results, painful to contemplate, must eventually occur. The utilization of sewage is dealt with fairly, and the appendix description of Japanese methods in regard to this will be read with much interest. It is impossible, in so small a space, to do justice to so admirable a work as that of Baron Liebig; and we can only console ourselves with the hope that the reader will be led to examine the volume for himself. The highest meed of praise is due to the able translator, who has certainly discharged his duty with more than usual care, and who is already so well known to the scientific world, that further comments on our part would be superfluous. Baron Liebig's book recommends itself to every one interested in, not only the theory, but the practice, of agriculture.

PHYSIOLOGICAL SCIENCE.*

PHYSIOLOGY is the basis of all rational medicine. It is to the physician what mathematical science is to the astronomer; and the medical man who attempts to treat disease without a thorough knowledge of the processes which are carried on in the body during health, is a mere empiric, who is elevated above the herbalist charlatan solely through the influence of conventionality. We are sorry to think that very many of our practitioners display a lamentable ignorance of the laws which govern the vital operations; but we confess that this, in our opinion, is due to the negligence of certain licensing bodies, who fancy that when they have ascertained that a candidate can amputate a thigh, and make a neat dissection of the external carotid, they have done all that is requisite for the advancement of educational interests. It is lamentable that such a state of things should exist; but that it does exist we have not the least hesitation in affirming. It is the more to be regretted, as there are few countries where so many and well-written text-books on Physiology are to be found as in that of Great Britain. Should the physician inquire, Where is the necessary information to be obtained? we can safely reply, In the work now under notice. Dr. Kirkes has been long and favourably known to the profession, and we venture to say that there is no name in science with which the medical student is more familiar than that of the author of the "Handbook of Physiology." The fifth edition of this fine work has just appeared, and no doubt will be welcomed to the library and lecture theatre with the hearty greetings it deserves. The book has undergone an entire revision, and, so far as we can see, has received many additions, bringing it up to the present state of scientific physiology. It must be borne in mind that Dr. Kirkes has written upon pure, or special physiology, as it is termed: that is to say, he has treated almost exclusively of the functions which the various organs perform, merely touching generally, upon the microscopic anatomy of the tissues. If, therefore, we say that the latter is hardly of as modern a type as an examination of Reichert's, Huxley's, and Beale's views might have rendered it, we must not be supposed desirous of passing any censure upon the writer. Those portions of the text devoted to functional physiology are written in a terse and lucid style, embrace the consideration of all recent investigations, and are illustrated by wood and other engravings of a very superior stamp. In the chapter on the chemical and histological character of the blood, the reader finds, not only the results of those researches which he is already acquainted with, but much valuable matter relating to the discoveries of the last few years. Bernard's discovery of scarlet blood in the veins of active glands and in those of inactive muscles is adverted to; and the same observer's statement, that the acidity of the blood when removed from the body is owing to conversion of its sugar into lactic acid, also finds a place. The nature of coagulation is referred to, and on this subject the

* "Handbook of Physiology." By WILLIAM S. KIRKES, M.D., F.R.C.P.S., etc. Fifth edition. London: Walton & Maberly. 1863.

views of Richardson, Lister, Nasse, Brücke, Polli, and the more recent ones of Schmidt, are well detailed. Dr. Kirkes does not appear to favour any *one* of the opinions put forward by various authors, in respect to the cause of the first sound of the heart; but while he admits the plausibility of Dr. Halford's theory, he conceives that,—

"The safest theory to be at present adopted, with regard to the first sound of the heart, is that which admits the co-operation of several coincident agencies in its production."

Professor Savory's recent observations on the influence of certain kinds of food are alluded to. We cannot, however, concur in the author's opinion, that they disprove Liebig's theory; as we believe, that while it *is* possible to prepare pure non-azotized food, *purely* nitrogenous materials are not so easy of production. In regard to the glycogenic function of the li er, we must say that we still look upon the matter as unsettled: Dr. Pavy's experiments were carried out with such precision, that we admit being unable now to accept either doctrine. The student will be pleased to find that the beautiful researches of Dr. B. Séquard are described by Dr. Kirkes, and are accompanied by an explanatory diagram, from the treatise of the former. In cases like the present, "comparisons are odorous;" but, even at the risk of being accused of partiality, we contend that there is no better work for students and practitioners than that of Dr. Kirkes. It possesses a copious index, and a list of references to the various English and Continental books and periodicals in which may be found the original memoirs on which the views expressed in the "Handbook of Physiology" are supported.

A MANUAL OF ZOOLOGY.*

A SECOND edition of the English translation of M. Milne-Edwards's book has lately come out. It is in part a posthumous work, for the original translator, Dr. Knox, died before the proofs had all passed through the press; and the labour of editor then devolved on Mr. C. Carter Blake. There have been so many persons engaged in bringing out this work, that we might naturally have anticipated a valuable result. We are sorry to say that we have been disappointed. Dr. Knox, though himself a first-class comparative anatomist, was but a poor zoologist; and, to judge from Mr. Carter Blake's revision of the volume, we should not say he was remarkably conversant with the progress which zoology has made during the past eight or ten years. When a new edition of a scientific book makes its appearance, we generally dip into its pages with the assurance that we shall find considerable alterations in the text, and old views abandoned, and more philosophic and firmly based ones substituted for them. We cannot say this of Mr. Renshaw's new publication. With the exception of about half-a-dozen new sketches and a few harum-

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* "A Manual of Zoology." By M. Milne-Edwards. Translated from the last French edition by R. Knox, M.D. Second edition. Edited by C. Carter Blake, F.G.S., &c. London: Renshaw. 1863.

scarum notes and intercalations, we find little improvement upon the edition of 1856. The physiological section of the work, though certainly not of an advanced description, is nevertheless good, and, as an introduction to the more special study, must be considered as of importance. The Vertebrata, as usually occurs, are treated of at length, and there is little fault to be found with the descriptions. It seems to us, however, that the outline of the nervous system is unwarrantably brief, and that the omission of all allusion to the vast amount of work done in brain-anatomy during the past five years, is hardly justifiable. That portion of the volume which embraces the Invertebrata is sadly deficient. We must take exception, especially, to the system of classification adopted in the instance of Annulosa, or *Annulata*, as it is therein styled. All modern investigations group the echinoderms with the Annuloida and not with the jelly-fishes; moreover, the beröe is no longer placed among the Acalephæ but in the order *Actinozoa*. The chapter on Geographical Distribution has undergone some slight change, and embodies a mild attack on the late Edward Forbes, which we think might have been omitted. We conceive that Mr. Blake would have shown some discretion had he avoided inserting *his* table of classification; it does not redound much to his reputation as a naturalist acquainted with the zoology of 1863.

GEOLOGY FOR SCHOOLS.*

THIS is an excellent little book; and though the author's modesty induces him to state that it is "intended for the use of young persons of fourteen or fifteen years of age and upwards," we have not the faintest doubt of its becoming the hand-book of amateur adults, and even of junior students. Those interested in geological science are already well acquainted with Mr. Beete Jukes's name as a writer of former treatises on popular science, and to the more serious student Mr. Jukes is familiar as the contributor of many valuable memoirs to scientific journals, and as the Director of the Irish Geological Survey. "The School Manual" is divided into three parts: in the first, the geological operations now in action are dealt with; in the second, some of the facts observable in the crust of the earth are exposed; and in the third is given the history of the formation of this crust, deduced from facts observable in it, as explained by reference to operations which are going on at the present time. The language in which the book is written is characterized by great clearness of style; and in every case where expressions borrowed from other sciences are employed, an explanation of their meaning is given. This is well illustrated in the few paragraphs on the "elements" which chemists speak of. The chapter on Earthquakes is particularly good, and in it we observe an analysis of Mr. Mallet's great work on Seismology. From what Professor Jukes writes respecting the move-

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* "The School Manual of Geology." By J. Beete Jukes, M.A., F.R.S., Local Director of the Geological Survey of Ireland, &c. Edinburgh; Adam & Charles Black, 1863.

ment of glaciers, he does not seem to have accepted Forbes's doctrine. His remarks on the various forms of stratification, and on their modification by internal and external influences, deserve perusal. We see for the first time the late Professor Kinahan's sketches of Oldhamia and Histioderma reproduced ; and from experience, can testify to their being capital representations of these peculiar Cambrian fossils. The palæontological division of the volume has been handled in as masterly a manner as the other, and both are adorned with hosts of well-executed woodcuts. We heartily wish Mr. Jukes's " Manual " every success.

LOCAL FLORAS.*

WE can never expect to get a thoroughly systematic "British Flora" till we possess accurate lists of the plants in each county, and properly drawn lines indicating their superficial and bathymetrical distribution. In the two volumes lying on our table a very laudable endeavour has been made to furnish the public with scientific catalogues of the plants found in Surrey and Marlborough. That which relates to the former county is the better of the two, but each is remarkably good of its kind. The " Flora of Surrey," we are informed, has been prepared from the manuscripts of the late J. D. Salmon, F.L.S., under the auspices of the Holmesdale Natural History Club. It is exceedingly systematic ; and were it not that its compilers have given admitted varieties the rank of true species, we should have little to complain of. The tendency of present botanists—of that school at whose head Bentham stands—is to reduce the number of so-called species very considerably. And we do not think we are going beyond the mark when we say, that the Surrey flora, as represented by Mr. Brewer, contains a hundred more species than the county possesses; in other words, five score of Mr. Brewer's species are mere varieties. Perhaps the best portion of the work, like the essence of a lady's letter, is to be found in the appendix. This contains a tabular arrangement of the plants, showing their geological distribution, which is further indicated on a beautiful geological map attached to the volume, and prepared expressly for it by Mr. Prestwich. It is, on the whole, a book which must prove very acceptable to all London botanists. The " Flora of Marlborough," which includes a list of local birds, is a far less pretentious volume, and, as its author states, was prepared for the members of the College, in order to induce them to take an interest in botanical science. Nevertheless, it has been well and creditably executed ; and, from the author's modest expression of doubt as to its accuracy in some particulars, it is evident that he is a cautious and industrious botanist, and one well adapted for the labour he has undertaken. True science is almost always sceptical.

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* " Flora of Surrey." From the MSS. of the late J. D. Salmon, F.L.S., and from other sources. Compiled for the Holmesdale Natural History Club, Reigate, by J. A. Brewer. London : Van Voorst. 1863.

" Flora of Marlborough ; with Notices of the Birds, and Sketch of the Geological Features of the Neighbourhood." London : Van Voorst. 1863.

A GUIDE TO THE WESTERN ALPS.*

THOSE who delighted to read "Peaks, Passes, and Glaciers," will, as a matter of course, be pleased to learn that Mr. Ball has again come before the public in connection with his favourite subject. This time, however, his object is, not merely to excite a desire for Alpine travel, but to show the amateur in what manner he can best set about his mountaineering excursion—how he is to conduct himself during his ascent of the Alpine peaks—and what he has to learn and observe. With Mr. Ball's book (and it is a very portable volume) in his pocket, the traveller has nothing to fear. And we believe, if the question were asked, it would be more difficult to say what topics connected with mountaineering are left untouched, than what are not. It has never been our lot to find a volume which contained so much information in so small a space; and yet the matter does not partake of that dry character which so frequently accompanies condensation. Mr. Ball gives us a few hints as to the form of money to be used, and the method of getting English coins exchanged for foreign ones; then he passes on to passports and custom-house regulations, till he brings us to the Alps. Next he has a word on the mode of travelling to be adopted in the Alps, speaks of *chars*, *diligences*, riding, &c., and supplies a list of names of the best known guides, with their addresses. The subject of inns is treated in full, and his advice to pedestrians is, we feel sure, excellent. Admirable essays on the zoology, geology, glaciers, and botany of the Alps, follow, and the first portion of the volume closes with a list of works on, and maps of, the Alps, which extends over eight or nine pages. The great bulk of the volume is absorbed by a detailed account of the different routes which may be pursued in travelling over the Maritime, Cottian, Dauphiné, South Savoy, Graian, and Pennine Alps. This section is accompanied by several tinted maps, and is so diffuse that we fancy the omissions have been few indeed. Large geographical and geological maps are appended, thus rendering the entire work a welcome companion for the mountaineering tourist.

OUR GARDEN FRIENDS AND FOES.†

TO those who have not read Mr. Wood's other works, this one may prove of interest. To us it savours very much of an old joint newly cooked, with just a sufficient addition of anecdotal condiments to make it somewhat palatable. To speak more freely, we look upon this volume as a compound, consisting of "The Common Objects of the Country," and certain other popular treatises of the same author, with a sprinkling of "Animal Traits and Characteristics," just sufficient to make the whole

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* "A Guide to the Western Alps." By JOHN BALL, M.R.I.A., F.L.S., &c. With an Article on the "Geology of the Alps," by M. E. DESOR. London: Longman & Co. 1863.

† "Our Garden Friends and Foes." By the Rev. J. G. WOOD, M.A., &c. London: Routledge & Co. 1864.

more readable. The professed object of the writer is to furnish the public with the means of distinguishing between those animals which are useful, and those destructive, in our ordinary gardens. Like all Mr. Wood's publications, it is written in a simple, easy style; and were it not for his frequent sneers at what he terms "the wish to be thought scientific," we could read it with pleasure. However, it is worthy of note that the author desires to be thought scientific himself, and in some few instances, where he lays down certain opinions on subjects in comparative anatomy, displays a very superficial knowledge indeed: for example, where, in speaking of the eyes of the wood-louse he states that they "are placed directly upon the surface of the integument." We presume he means that they are not stalked; but this negative conclusion does not support the positive assertion that they are placed directly *upon* the integument. Regarded as a purely popular work, abounding in amusing anecdotes, there are few which can equal it; but it cannot be considered calculated in any way to assist in teaching the grand scheme of Biology. It is a book of interesting facts in natural history—nothing more. It comprises descriptions of our commoner garden Annulosa, Mollusca, birds, mammals, and reptiles; and, besides the woodcuts scattered through the text, a series of plates is appended, containing representations of various insects, Lepidoptera especially. As regards type and other mechanical features, the work deserves commendation.

DICTIONARY OF NATURAL HISTORY TERMS.*

THE working naturalist occasionally finds himself posed by some technical expression, which throws itself in his way, and which, if he stumble over it, leaves him in such a position that his scientific journey must be arrested. Ere he can advance a step, this obstacle must be removed, and its removal is sometimes a matter of no very great ease. But if the man of science finds himself, once in a way, brought to a standstill by a word of two or three syllables, how often must the amateur naturalist be placed in the same predicament? We answer, frequently, and we believe our reply will be endorsed by the majority of our readers. He can only hope for a solution of the puzzle by an appeal to some natural history encyclopædia, which is both unwieldy and expensive; and it now and then happens that his search proves a fruitless one. The interruption we allude to need no longer exist. The want so long experienced has been supplied. Dr. McNicoll's Dictionary will afford both amateurs and workers much assistance, embracing, as it does, an explanation of more than *fifteen thousand* technical terms employed in the kindred sciences, Botany, Zoology, and Palæontology. It is not to be expected that a book of this kind could be perfect, especially in its first edition; but the imperfections are remediable, and we trust that, in a future issue, they may be

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* "Dictionary of Natural History Terms, with their Derivations; including the various Orders, Genera, and Species." By David H. McNicoll, M.D., &c. London: Lovell Reeve & Co. 1863.

removed. The terms are arranged in alphabetical order, and the Greek or Latin derivation, and the name of the branch of natural history to which it belongs, follow each word. Thus :—

Antennæ (Entomology), *ante*, before, *teneo*, to hold.
Coriandrum (Botany), κόρις, a bug ; in allusion to the smell of its leaves.

May we urge upon the author the propriety of adding to every term the name of the genus with which it is connected? Thus, in the case of *Acinetæ*, instead of merely adding the very general expression "Zoology," we would suggest the addition of the words, "applied to the reproduction of Infusoria," or some such explanation. Many other instances of a similar character may be found; but we merely refer to one, in order to call the author's attention to the matter. Viewed in its entirety, the book is a most valuable one, and should be on the library shelves of every one interested in natural history pursuits.

AN INTRODUCTION TO ASTRONOMY.*

MR. BOHN'S popular scientific publications rank among the best, and assuredly the work before us is in no way behind the mark. Clear and untechnical in his descriptions, Mr. Hind has exposed the ordinary astronomical phenomena in such a manner as to render his volume alike acceptable to the general reader and the student. From the circumstance that *Physical* Astronomy is closely associated with mathematics of the highest order, this branch of the subject has been wisely omitted ; but as far as *Plane* Astronomy is concerned, we deem the present work capable of imparting all the information which even the most ambitious amateur can desire. It opens with a series of definitions of a preliminary character, and a general outlinear description of the universe, which embraces the important and minor planets and the fixed stars. The explanation of the production of the different seasons is remarkably lucid ; and Kepler's three great fundamental laws are enunciated in terms intelligible to every one. Many good folk whose notions of astronomy are of a misty character are disposed to think that attraction of gravitation is the cause of the planets' motions : the real influence of this force being merely to produce the orbits. On this point our author is very explicit. In speaking of universal gravitation, he says : "It is by the action of this force that the planets are retained in their orbits round the sun, having once received from the Divine hand the *impulse* that set them in motion." The precession of the equinoxes—a great stumbling-block to beginners—is as happily dealt with. Nutation, Eclipses, the Tides, Parallax, Comets, and Nebulæ next receive the author's attention. The sun and planets are minutely

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* "An Introduction to Astronomy ;" to which is added an Astronomical Vocabulary, containing an explanation of terms in use at the present day. By J. R. Hind, F.R.A.S., &c. London : Henry G. Bohn. Third Edition. 1863.

described, and a list of the minor forms of the latter, extending to the discovery of Luther in last March, forms part of this section. The book is profusely and well illustrated, and contains an astronomical vocabulary covering nearly sixty pages, thus completing a volume to which we have much pleasure in directing the attention of all our readers.

VITAL PHENOMENA.*

DOES the reader desire a work compounded of mild evangelicalism and extremely dilute science? Does he wish to associate superficial and imaginative philosophy and religion to the utter annihilation of everything Socratic? If so, he should peruse Mr. Grindon's essay on "Life." To us it is one of those inexplicable mysteries, only to be solved in future ages, how publishers can be found to undertake the publication of books like the present one. We were about to express our surprise that persons connected, even indirectly, with science, could be found to write them; but our knowledge of the frailty of human nature nipped the sentence in the bud. What shall we say of Mr. Grindon's production? That it is well written? Yes: we can conscientiously award the author our tribute of praise in this regard. The style, were it not for a few pedantic and wildly-conceptive flights, might be termed excellent. It has, at least, the merit of being readable, but that is all we can admit in its favour. As a popular medium for the communication of science, it is absolutely valueless. Recognized and exploded theories are indiscriminately introduced, and, from the author's comments, it would appear that he occasionally is at a loss to understand either. He aims at being metaphysical, and therein we think he errs. Thus, he entirely misinterprets the beautiful doctrine of the correlation of forces, and in his confused notions of the functions of the body invokes the assistance of a vital force. Again, he speaks of the sluggish life of the Annelida, proving his ignorance of that group, which has been specially designated *Errantes*. When attributing the movement of the blood in plants to the Divine cause alone, he shows that he is unacquainted with Draper's grand researches. The absurd generalization of a single animal archetype should not have been introduced, and the question of homologies is one which is even yet so undecided that it had much better have been omitted. The more animal forms are investigated, the more forcible becomes the conviction that there are several types fundamentally distinct from each other. We could adduce many other instances of Mr. Grindon's erroneous teachings, but space forbids. We regard his volume as a melancholy example of what extravagances a man who combines pseudo-metaphysics, imperfect science, and superstition, may be led into.

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* "Life: its Nature, Varieties, and Phenomena." By LEO H. GRINDON, Lecturer on Botany at the Royal School of Medicine, Manchester, &c. Third Edition. London: Pitman. 1863.

POPULAR NAMES OF BRITISH PLANTS.*

THE popular names of our native plants are, we fear, too much neglected by teachers of taxological botany. We are, therefore, glad to find that an attempt has been made to prevent their extinction, and accordingly we welcome Dr. Prior to the field he has selected. Undoubtedly, the task of explaining the signification of the common names of plants is an exceedingly difficult one; hence, if we find some of our author's explanations a little conjectural and unsatisfactory, the writer can hardly be reproached severely for what was evidently due rather to the lack of existing information than to his endeavours to compile from all available sources. The plan of the book is to be approved of, but the matter is of so dry and encyclopædic a character, that we fancy it will not be so generally read as the more interesting descriptions which the talented editor of "Sowerby's English Botany" has already given to the public. For all that, it is a most valuable compilation. A quotation will expose its merits better than any remarks of ours. Let us select the Fumitory for example:—

"Fumitory, French *fume-terre*, Latin *fumus terræ*, earth-smoke, from the belief that it was produced without seed from vapours rising from the earth. *See* Ortus Sanitatus, Mayence, 1485, ch. 176, and the Grete Herball, cap. clxxi., where we are told that it is 'called Fume, or smoke of the earth, because it is engendred of a cours fumositie rysing from the earthe, and because it cometh out of the earth in great quantity lyke smoke; thys grosse or cours fumositie of the earthe, wyndeth and wyndeth out, and by working of the ayre and sunne it tourneth into this herbe, &c.'"

There are other names, however, whose origin is not so well explained. We do not think that *Bedstraw* is so called from having been formerly employed for bedding; nor do we believe that the term *Alder* is derived from an awl, because it may have formed the handle of the latter instrument. Viewed in its *tout ensemble*, Dr. Prior's book is a useful and important production, and in the hands of the field-botanist will constitute a capital adjunct to the British Flora.

THE BIRDS OF EUROPE.†

THOSE who possess the preceding volumes of this splendid work will hail the appearance of the fourth and concluding portion with feelings of intense satisfaction. It comprises the natural history of nearly fifty birds which, though recorded as having been found in Europe, are not British. The technical characters, both generic and specific, are intelligible to the zoologist, and the general features are given in so popular a style,

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* "On the Popular Names of British Plants," &c. By R. C. A. Prior, M.D., F.L.S. London: Williams & Norgate. 1863.

† "A History of the Birds of Europe not observed in the British Isles." By C. R. Bree, M.D., F.L.S. Vol. IV. London: Groombridge & Sons. 1863.

that, with the assistance of the beautifully executed plates, the merest tyro must find the identification of a species a very simple matter. If there be any fault in the illustrations, it is that they are perhaps a little too highly coloured, in other respects they are perfect; and as there is a sketch of every bird which is described in the text, the book will prove interesting even to those who have not the good fortune to possess a museum of their own. In many cases representations of the eggs are given, a circumstance which lends an additional importance to the work. The chapters on the Wandering and Yellow-nosed Albatrosses are especially worthy of perusal. The strange voracity of the former is described in vigorous language, and its power of flight within two points of the wind is also adverted to; the latter species, too, is fairly noticed. The wandering albatross is most probably the bird to which Coleridge alluded in his celebrated poem; and no doubt Dr. Bree's description of it will be read with *gusto* by all who are familiar with the "Ancient Mariner." We may mention that, in treating of the habits of the birds, the author has depended in great measure upon the observations of others; but his selections are good, and are always verified by the names of the writers from whom they are borrowed. Dr. Bree has discharged his duty faithfully and successfully; and, whilst wishing his treatise an extensive circulation, we hope we are only bidding him *au revoir*.

CHEMICAL PHYSICS.*

EXPERIMENTAL Physics is a subject which, in these days, everyone must be less or more conversant with. In every class of educated society the topic of conversation is occasionally some one bordering on physical science; we are asked our opinions as to the progress of spectral analysis, or as to the diffusion of gases, or some friend who has been to the Royal Institution, inquires whether we are disposed to accept Professor Tyndall's views. Now, those whose professional pursuits carry them out of the track of science may naturally inquire, Where can we obtain a knowledge of physics? Where shall we find accurate information respecting the electric and such like forces, the nature of heat, the structure of the spectroscope, &c.? Our answer is, in the volume before us. Its third edition has now been published, and comprises the most recent results of physical investigation. It treats of the laws of chemical combination, elasticity, diffusion of liquids and gases, crystallization, light (including an account of Bunsen's and Kirchoff's discoveries), heat, electricity, and magnetism. We hardly think the views of Gerhardt have been done justice to; but any deficiency in this respect is amply compensated for by the comprehensive treatment of other questions. That the most recent discoveries have been considered, is evidenced by the fact that

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* "Elements of Chemistry, Theoretical and Practical." By William Allen Miller, M.D., LL.D., V.P.C.S., Professor of Chemistry in King's College, London. Part I.—Chemical Physics. London: Parker, Son, & Bourn. 1863.

Tomlinson's curious researches on cohesive figures have been in part introduced, and that Graham's discovery of dialysis is described. We have not seen any allusion to his *atmolytic* investigations, but we presume they appeared too late for insertion. The pages devoted to spectral analysis embrace everything that has been done upon the subject, and contain even reference to Plücker's discovery which was not announced till last April. Tyndall's researches are carefully detailed, and the chapters on static and voltaic electricity are all that could be desired. The style is clear and forcible, and the woodcuts are numerous and well-executed. As a text-book, Dr. Miller's volume is unquestionably the best of its kind, and must be read by the student of natural philosophy; whilst, at the same time, we think it well worthy the perusal of serious non-professional readers.

DISEASES OF THE EYE.*

AS old age steals upon man, not only is "his natural strength" abated, but his powers of vision are impaired, and his eyes become dim. This ocular obscurity may be the result of one or more of several distinct alterations of the structure of the organs of sight. Some warn us of their approach by reason of their effects, others are more stealthy in their progress. Some are attended almost invariably with a partial or total impairment of the visual sense, others are comparatively harmless. To the second and fourth categories belongs the class of ophthalmic disease upon which the excellent monograph just published treats. "Arcus Senilis" is the title of Mr. Canton's book. What is Arcus Senilis? Literally, it means *the old man's bow;* and surgically, it is a term applied to a disorganized crescentic structure which appears in old age at the borders of the transparent portion of the eyeball. This phenomenon is produced by a degeneration of the healthy tissue, which gives place to a quantity of oily matter devoid of transparency. Hence, it is also termed "fatty degeneration of the cornea." We think Mr. Canton's quotation from Paget's writings ill-advised; it is merely a thoughtless jest at the expense of our modern school of comparative anatomists, and we allude to it only because he has selected it to ornament the first page of his beautiful memoir. Waiving this, we do not grudge our praise to almost every other portion of the work. The history of the malady justifies the opinion that the author is as thoroughly master of this branch of the subject as his great reputation proves him to be in every other. The pathology of the cornea has been carefully studied, and is illustrated by reference to both original and borrowed engravings In this department due attention has been bestowed on the opinions of the German and French schools of ophthalmologists; and although the objectives employed have been of comparatively low magnifying powers, yet the structure, or absence of structure, has been tolerably well revealed. The lithographic plates are good, but not as perfect as they might be. The cases appended are admirably recorded, fully confirm the author's views,

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* "On the Arcus Senilis, or Fatty Degeneration of the Cornea." By EDWIN CANTON, F.R.C.S., President of the Medical Society of London, &c. London: Hardwicke. 1863.

and convey even to non-surgical readers a considerable amount of instruction. Mr. Canton's treatise, while being accurately scientific, is devoid of that professional pedantry which we so frequently find in surgical books; and it combines so much historic lore with ophthalmic fact, that one travels over its pages with almost as pleasurable a feeling as though it had been a romance.

MANUAL OF THE METALLOIDS.*

SCIENCE is not behind-hand on the other side of the Irish Channel. Messrs. Galbraith and Haughton, both Fellows of the University of Dublin, have been among the foremost in giving an impetus to Irish science, and we on this side of the water have materially benefited by their exertions. These gentlemen have lately been engaged in bringing out a new series of Manuals, uniform with those on pure and mixed mathematics; but this time the natural and experimental sciences have received their attention. The book upon our table is the third of the series, and by far the best of the three; for whilst the two others are beset with technicalities of a very unnecessary character, the present one is at once philosophic and clear. This, however, is only what we might have expected from so distinguished and erudite a physicist as the Professor of Chemistry in the University of Dublin. The introduction, which to our mind is the most successful portion of the work, extends over about one hundred pages. It is divided into a number of sections, of which one is devoted to each of the following subjects:—Laws of Combination, Equivalent Numbers, Atomic Weights, Notation, Law of Volumes, Atomic Volume, Isomerism, Isomorphism, Dimorphism, Reaction of Bodies on each other, Berthollet's Views on Decomposition, and the Unitary System. The latter is detailed more clearly than we have found it to be in any other treatise, and we can commend it as a most impartial exposition of both sides of the case. The more purely chemical division of the Manual is thoroughly good, but has little novelty, save the introduction of a far larger proportion of experimental physics than is usual,—a feature, by the way, which we consider is much in its favour. The subject of coal gas is dilated on at length; and there is a useful appendix "On the Analysis of Gases." In conclusion, we may observe, that Dr. Apjohn's Manual bids fair to become a frequent visitant to both laboratory and lecture-room.

A MANUAL OF MINERALOGY.†

IN this book the mineralogist meets with an old friend in a somewhat new garb. The present volume, which is one of a new edition, has been revised and enlarged, and contains much matter unpossessed by the

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* "Manual of the Metalloids." By JAMES APJOHN, M.D., F.R.S., M.R.I.A., &c., Professor of Chemistry in the University of Dublin. London: Longman & Co. 1864.

† "Manual of Mineralogy," &c. By JAMES D. DANA, A.M. London: Trübner & Co. 1863.

first edition. To most folk mineralogy is an exceedingly dry and uninteresting pursuit; and certainly, if one may be permitted to form the opinion, it seems that those who calumniate the science have good reason to do so, although they themselves are to blame and not mineralogy. How often we meet with persons styling themselves mineralogists, who really know just as much about the philosophy of their subject as though they were unable to distinguish a piece of quartz from a crystal of carbonate of lime! Such individuals will talk about *Chiastolite* and *Andalusite*, and yet will be unable to explain the simplest phenomenon in crystallography, or to say what chemical relation one mineral holds to another. Is it, then, strange, that those ignorant of the science should not be much prepossessed in its favour, when their only conceptions as to its nature are derived from these quasi-mineralogists? Certainly not. We trust that Mr. Dana's book will generate a better spirit, by developing a desire to become acquainted with the principles of the science. This Manual of Mineralogy is the most diffuse we have yet become acquainted with, and is well calculated to promulgate philosophic ideas. The subjects of crystals, and the laws which control their formation and modification, are explicitly enlarged upon; and the physical properties of minerals, as given by the author, will be found of great service to the practical mineral-hunter. The descriptions of the various minerals are good, but the localities cited being nearly all American, the student will occasionally find himself at a disadvantage. The analytical key to the discovery of any mineral's name is based, we think, on rather unimportant characters, but to one of good powers of manipulation must prove very valuable. We heartily recommend the volume.

NEW INVENTIONS.

HARDENING AND COLOURING GYPSEOUS LIMESTONE.—*Mr. R. A. Brooman, patentee.*—In hardening gypseous limestone, the stone is first reduced to pieces of artistic dimensions, such as are suitable for balustrades, friezes, columns, &c. They are then dried in a stove heated to a certain temperature. After removal from the stove, the pieces of stone are placed in a bath containing a mineral solution. The bath may be composed of lime-water, sulphate of iron, cyanides, alumina, potass, soda, or vegetable substances, perfectly combined with minerals or substances obtained from alkaline matters. For colouring, recourse is had to a chemical operation, whereby a transformation of colours is obtained, by making one solution to chemically succeed another.

TREATING GASES CONTAINING SULPHURETTED HYDROGEN.—*Messrs. Baggs & Simpson, patentees.*—The objects of this invention are, firstly, to deprive coal-gas of elements which render it injurious to the animal and vegetable kingdom; and, secondly, to manufacture useful products from or with the elements of which the coal-gas has been deprived. This is effected by causing the gas to come in contact with metallic compounds, by blowing or otherwise, whereby the injurious adulterative matters are separated by decomposition or appropriation. The metallic compounds employed are mainly metallic oxides and salts, whether neutral salts, super-salts, or sub-salts, having a strong affinity or attraction for sulphur, carbonic acid, and other impurities, and which are themselves susceptible of renovation or recovery. The oxides and salts of copper, lead, magnesia, and other bases, may be used for these purposes.

MAKING DYES FROM ANILINE.—*Messrs. R. T. & R. Monteith, patentees.*—Aniline red, which is made from aniline or one of its analogues, is mixed with a dry salt of aniline, and heated in a vessel, either hermetically closed or not, to a temperature of 390° Fahrenheit, and upwards, from one to six hours. The dyes thus produced are shades of brown, called in France "Cairs" and "Havanne." The brown dye may be separated into two brown dyes of different shades, a part being soluble in boiling water, and nearly all the rest in alcohol. The mass which results from heating the aniline red, and the dry salt of aniline, must be treated with a sufficient quantity of boiling water to dissolve out all that is soluble in it, and then filtered, and the residue treated with alcohol, and filtered. Both filtrates will dry brown, but of different shades. These dyes may be used at once for dyeing textile fabrics and yarns, or they can be purified by any of the methods in general use for purifying aniline colours before dyeing with them.

PRODUCING COLOURING MATTERS.—*Mr. W. E. Newton, patentee.*—This invention refers to a process for obtaining from naphthaline a yellow

dye, which may be used either alone for dyeing yarns or threads and piece goods, or be treated with suitable chemical reagents for varying its hue as desired. One hundred kilogrammes of naphthaline are boiled for a few hours in an acid solution composed of 200 kilogrammes of water and 20 kilogrammes of nitric acid at 30° Beaumé. The naphthaline must be kept well stirred while dissolving in the boiling water and acid, and the agitation must be maintained until the mixture has become cold. The mother liquor is next drawn off, and the naphthaline will then present the appearance of brown crystals. These crystals are now washed in cold water to remove the acid. In order to obtain a yellow solution of colouring matter, the crystalline product is to be treated with boiling water, to which is added 5 kilogrammes of liquid ammonia. The solution thus obtained is to be filtered, and subsequently evaporated into a concentrated state. The concentrated solution must in like manner be filtered, and when cold it will be ready for use.

Manufacture of Blue and Violet Colouring Matters.—*Messrs. Poirrier & Chappat, patentees.*—For the purposes of this invention, the aniline reds (known in commerce under the names of fuchsine, roseine, magenta, and under other names, and, chemically, as being different salts of rosaniline) are treated with naphthylamine—a substance which is derived from naphthaline, as aniline is derived from benzine.

Manufacture of Blue Colours.—*Mr. A. P. Price, patentee.*—The main feature of this invention consists in the employment of acetates, citrates, succinates, racemates, malates, valerinates, carbolates, benzoates, cinnamates, tartrates, and oxalates of potash, soda, and ammonia, in conjunction with aniline, roseine, and rose-aniline, in the production of blue colours.

Rendering Cloth and Paper Transparent and Waterproof.—*Mr. E. T. Hughes, patentee.*—The objects here in view are effected by the use of a composition composed of one part by measure of linseed oil, one part of india-rubber cement, and six parts of benzine. This, for most purposes, constitutes the best mixture; but for a preparation of tracing-cloth and tracing-paper of close texture, it may be advisable to use an additional proportion of benzine, to avoid producing a gloss on the outside, and also to avoid filling the pores of the paper too full to retain the ink and colours which may be applied.

Aromatic Vinegar.—*Mr. H. A. Boneville, patentee.*—The patentee claims the use of the ethers, amyl-acetic, ethyl-acetic, and methyl-acetic, as the base of a new aromatic and at the same time hygienic vinegar, which may be used for removing stains from stuffs of all kinds, without altering their shades, whether employed alone, or mixed together in equal parts, dissolved or not in absolute alcohol, acidulated with acetic acid for reviving certain colours, or aromatized by the addition of certain perfumes.

Voltaic Belts.—*Mr. R. A. Brooman, patentee.*—In constructing belts and bandages in accordance with these improvements, they are composed of a bi-metallic core, consisting of plates, strips, or blades of metal, one electro-positive to the other, such as copper and zinc, forming a voltaic battery, juxtaposed or placed one against the other, and covered with

some fabric or material which will keep them in place, and to which buckles, tapes, or other means of fastening are applied to secure them to any desired part of the body. The plates, strips, or blades may be of any form, according to the part to which they are to be applied. The moisture of the body will generally suffice to excite the bandages to action. They may, however, be excited by vinegar, or diluted acid, more or less strong.

Fixing Artificial Teeth.—*Mr. D. W. Ransom, patentee.*—These improvements are more particularly applicable when fixing teeth in vulcanite or like mounted bases. Artificial teeth have before been made with metal pins, which have usually been bent in opposite directions, in order that when the base of vulcanite, or other suitably formed base, has been constructed and rendered hard, the teeth may be held securely to the base. Here the patentee forms the pins, or it may be a single pin, with a screw thread or threads thereon, or with notches: if two or more pins be applied to a tooth they may be arranged parallel to each other; but it is better that they should incline away from each other.

Producing Gas.—*Mr. W. H. Buckland, patentee.*—In producing gas for illuminating and heating purposes according to this invention, air or gas is carburretted by causing it to pass over the surface of, or through, woven fabrics or fibrous or spongy substances which have the property of sucking up and exposing the liquid hydro-carbon in a finely divided state.

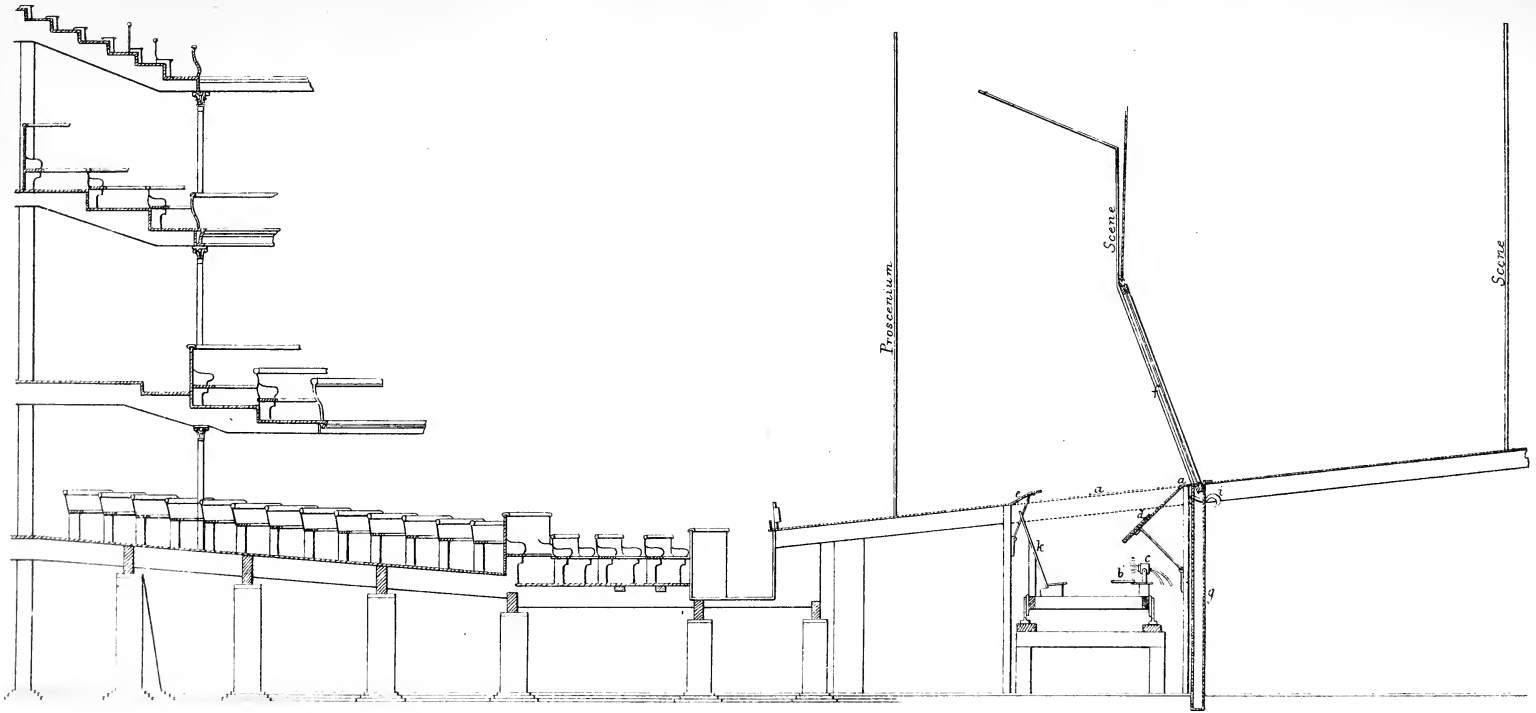
Treating Steel and Iron Prepared by the Pneumatic Process. —*Mr. J. Mushet, patentee.*—The essence of this invention consists in thoroughly mixing, without the agency and deteriorating effects of the pneumatic blast, melted speigel eisen or other melted alloys—such as alloys of tungsten of iron, or titanium of iron—with melted steel or malleable iron prepared by the pneumatic process from melted pig iron or cast iron, which mixing the patentee effects either by the use of two or more pneumatic or decarbonizing vessels, each containing melted steel or malleable iron made by the pneumatic process, to the steel or malleable iron in one or both of which two vessels the melted speigel eisen or other melted alloy has been added, the contents of one vessel being poured into the other, so as to internally mix and make the whole of uniform composition.

Reproducing or Obtaining Facsimiles of the Veins, Pores, Knots, and Figures of Wood upon Paper and other Surfaces. —*R. A. Brooman, patentee.*—In carrying these improvements into practice a smooth plank or piece of wood is covered with a coating of paint, which is made to penetrate the pores and veins of the wood; all the paint remaining upon the smooth surface of the wood is removed by a scraper, leaving only such of the paint as has penetrated the pores and veins. A very thin plate of copper, or other metal, is coated on both sides with a thin layer of wax, and this metal plate is applied upon the wood prepared as above described. The metal plate is pressed strongly upon the wood by a roller or otherwise, and the paint is thus forced from the pores or veins of the wood, and adheres to the wax upon the metal plate. The plate is then removed from the wood, and all the parts of the wax to

which the paint has adhered are scratched off with a sharp-pointed instrument, so as to expose the metal beneath those parts. The plate is next plunged into a bath containing nitric acid, or aquafortis; the acid enters all the parts from which the wax has been removed and bites through them. All the pores and veins of the wood are thus reproduced by the spaces bitten out of the metallic plate. The plate is washed with water to cleanse it, and the wax is removed by a bath of essence of turpentine or other spirit. The metal plate thus prepared serves for the reproduction of the veins, pores, knots, and figures of wood upon any surface, whether previously prepared by oil, paint, or otherwise. For instance, the plate is applied upon a surface painted with a ground colour, and a brush charged with paint of the colour of natural veins and knots is passed over the plate; the paint passes through the spaces or openings in the plate, and adheres to the surface beneath such spaces or openings only; and thus an exact copy of the veins, pores, knots, and figures of the wood is obtained.

Apparatus to be used in Dramatic and Similar Performances.—*Messrs. Dircks and Pepper, patentees.*—(Plate X.)—The object of this invention is, by a peculiar arrangement of apparatus, to associate on the same stage a phantom or phantoms with a living actor or actors, so that the two may act in concert; but which is only an optical illusion as respects the one or more phantoms so introduced. The arrangement of the theatre requires, in addition to the ordinary stage, *a*, a second stage at a lower level than the ordinary one, hidden from the audience as far as direct vision is concerned; this hidden stage is to be strongly illuminated by artificial light, *b*, *c*, and capable of being rendered dark instantaneously, while the ordinary stage and the theatre remains illuminated by ordinary lighting. A large glass screen, *f*, is placed on the ordinary stage and in front of the hidden one. The spectators will not observe the glass screen; but will see the actors on the ordinary stage through it, as if it were not there; nevertheless, the glass will serve to reflect to them an image of the actors on the hidden stage when these are illuminated; but this image will be made immediately to disappear by darkening the hidden stage. The glass screen is set in a frame so that it can readily be moved to the place required, and it is to be set at an inclination, to enable the spectators, whether in the pit, boxes, or gallery, to see the reflected image. The glass is adjustable, and it is readily adjusted to the proper inclination by having a person in the pit and another in the gallery to inform the party who is adjusting the glass when they see the image correctly. The right hand portion of the Plate (Plate X.) represents the stage arrangements. The left is an ideal section of the pit, boxes, and gallery of a theatre.

Brewing.—*Mr. J. Maxfield, patentee.*—It is desirable that the yeast arising from malt liquors should be kept separate from the liquor as it rises during the process of fermentation; and that the carbonic acid gas should be retained in the malt liquor, and the too free entrance of air be prevented. These improvements consist in the use of a cover floating upon the surface of the malt liquor, and furnished at the edges with india-rubber, to form an air and water tight joint between the edge of the cover and the inside of the vat. This floating



Ghost Apparatus

W. West, Lithr

NATURAL HISTORY

cover is provided with a tube extending upwards, through which the yeast passes and falls on the outside of the cover. Valves are also employed in the cover, opening inwards, and connected with tubing by which any liquor the yeast may contain passes again into the vat. The patentee also uses within the vat coils of piping supplied with hot or cold liquid to regulate the temperature of the liquor, as usual, and taps for drawing off the malt liquor from beneath the cover when the barm is separated. By the use of this floating air-tight cover, the height of the liquor in the vat becomes immaterial, and the free escape of the carbonic acid gas is prevented.

Preventing Fermentation in Liquids while Drawing them from Vessels.—*Mr. W. Clark, patentee.*—These improvements comprise an apparatus to be applied to the barrel or receiver, communicating on the one hand with the receiver, and on the other with the external air. The apparatus contains a disoxygenating solution, so arranged that the atmospheric air cannot enter the barrel without passing through the solution, and giving up its oxygen. In this manner, in place of the liquid drawn off at each time, there will be introduced an equal volume of azote; and although the azote may be in contact with a fermentable liquid, it will be incapable of fermentation when free from oxygen. The disoxygenating solutions the patentee ordinarily employs consist of sulphate of lime and sulphite of protoxide of iron, either together or separately, and dissolved.

Refrigerators.—*Messrs. Morris & Newton, patentees.*—The top of this improved refrigerator is divided into three compartments; that in the centre being intended for the ice-well, and those at the sides to contain wine, water, and other liquid to be cooled, to which cooler taps are applied. The waste water from the ice-well is conveyed to a cistern beneath another ice-well at the bottom of the refrigerator by means of wide, flat, or other suitably shaped channels formed in the back and sides. The top, sides, and back are packed with a packing consisting of burnt cork, charcoal dust, or other suitable material. The rim of the lid when closed falls into a small channel filled with water, which keeps the ice-well air-tight. A lower ice-well extends over the whole bottom of the refrigerator, from which the waste water is conveyed to the cistern immediately beneath, from which it is withdrawn by means of a tap. By forming the channels for conveying the waste water from the upper ice-well in the back and sides, and having an ice-well at the bottom, the usual central division is entirely dispensed with, thereby obtaining increased space in the interior thereof, and effecting a saving of at least 100 per cent. in the consumption of ice. The patentees make the ice-chests, refrigerators, and other like articles, portable, and of any size or shape, and entirely of zinc, galvanized iron, or other suitable metals, thereby dispensing with the wooden casing as at present used.

Sheathing Iron Ships.—*Messrs. Palmer & McIntyre, patentees.*—These improvements consist in fixing to the iron plates of the ship or vessel, or to iron for other similar uses, strips of metal which the patentees prefer to be of galvanized iron, in which strips are inserted rivets of copper or other suitable soft metal; these rivets protrude from the strips

in such a manner as to admit of strips of copper, "Muntz metal," zinc, or other sheathing previously punched, being applied thereto, and held thereby. By this arrangement, the strips fixed to the vessel form carriers for the sheathing, and obviate the necessity of perforating through the ship's side. The strips are double, that is to say, there is an outer and an inner strip, and they are applied to the plates of the vessel by means of screws or rivets passing through both strips and into the plates, the copper rivets having been previously inserted in an opposite direction in the outer strip. The sheets of copper, "Muntz metal," zinc, or other sheathing, are put on to the projecting copper rivets, with their edges overlapping, so that the ends of two sheets are held by one row of rivets, and tarred felt, hair, or other similar non-conducting material is inserted between the iron plates of the vessel and the copper or other metal sheathing. The projecting portions of copper are then hammered so as to securely rivet them.

Sheathing Iron Ships.—*Mr. W. R. Mulley, patentee.*—In attaching metal sheathing to iron ships' bottoms, caissons, and other like structures, according to these improvements, the patentee takes two pieces of angle iron with ⊥ on one edge. He prefers the iron to be $\frac{3}{16}$ inch thick, angle flange $\frac{1}{4}$ inch wide, and two ⊥ flanges together 1 inch, so as to leave about $\frac{3}{8}$ inch in projection on each side. He places them vertically and parallel to each other about 18 inches apart on the ship's side. He then introduces a length of say $1\frac{1}{4}$ inches wood sheathing between or immediately behind the frames, using a portion of their rivets to fasten them on, the grooves in the end of which correspond with the projections of the ⊥ flange formed to receive them. He fastens one of the irons by tapscrews, or rivets. He then lays on the ship's skin, hair and tar, or any other suitable composition, puts one end of the wood in its place, then brings the other iron against the other end, always with the flange outwards, and so on throughout. The ends of the separate pieces of sheathing meet on the tops of the irons, and the whole presents a surface as upon a wooden ship. He then caulks it and covers it with pitch and felt, so as to render it perfectly impervious to water.

Steering and Manœuvring Ships.—*Messrs. Dunbar & Woodford, patentees.*—Here the patentees employ an upright shaft or axis at or about the centre of a ship or vessel, the lower end of which passes through the bottom, and has affixed to it radial blades or vanes which come just below the bottom of the ship or vessel, or within a recess formed in the bottom. The upright shaft or axis passes within a tubular passage fixed within the ship, which rises to a height sufficiently above the water line; or a suitable stuffing-box or other provision is to be made, in order that no water may get into the ship or vessel; and when desired, the shaft or axis may be raised, in order that the vanes or blades may be replaced. The shaft or axis is acted on by steam or other power, to give rotary motion thereto, in order that the axis or shaft, and the blades or vanes thereon, may be caused to rotate towards the right hand or to the left, according to the direction in which it is desired that the vessels should be steered.

Armour Plates.—*Messrs. Clapp & Coats, patentees.*—In carrying out these improvements, the patentees employ plates of iron, or other suitable

metal, with curved and with flat portions, and through the flat portions they pass bolts or rivets to secure the same to the framing of the vessel, turret, target, fort, or structure, in such manner that other curved plates may be placed over the flat portions of the first-mentioned plates, and over the joints thereof, to cover and protect the bolts or rivets first mentioned, the last-mentioned curved plates being bolted or rivetted through the first mentioned curved plates, or otherwise, or secured in any equivalent manner. By these means additional strength is obtained, and the principal, and, if desired, the major part of the joints and bolts, or rivet-heads, is protected, so that a single plate shall not receive all the force of any projectile or striking body, but such force be distributed over the whole of the plates.

Mariners' Compasses.—*Mr. R. Alexander, patentee.*—These improvements have reference to the use of compensating or adjusting media, or both in combination, to render the magnetic needle independent of the local attraction of iron or other metals, metallic ores, or compounds, in the ship, vessel, or other place where the compass or needle is fixed. The means by which the patentee proposes to effect these improvements are—1. By appliances of counteracting and adjusting magnets, or magnetic poles, upon the compass needle-card or cards, or otherwise placed; 2. By the use, if necessary, of a moveable magnetic ring or rings, attached to the needle-card by springs or otherwise, so as to be easily removed when it is required; 3. By the use of a series of magnets, placed on or in a flat or curved surface, with or without rims or bands of soft iron, stationary or revolving, above, below, or horizontal with the middle card or cards, or both above and below them; 4. By the application of electricity or galvanism in conjunction with a part or the whole of the aforesaid appliances; 5. By the use of one or more magnetic needle cards, and one or more of the appliances explained above, placed one above the other, revolving in union with or independent of each other on the same (or on distinct) pivots, or one or more of them stationary and another or others revolving, or any one or more of them used in conjunction with a simple magnetic compass card, as commonly used, only revolving on distinct pivots, whilst a part may be stationary; 6. By the use of aluminium metal for the needle-cards, or india-rubber composition, commonly called ebonite, for the cards, rims, bowls, hoods, boxes, binnacles, and gimbals, and other parts of the compasses and appliances, or an admixture of steel filings or cuttings in the india-rubber composition for some of these, or the whole of the said parts above referred to; 7. By the use of hollow iron spheres or spheroids to encompass a part or the whole of the apparatus; 8. By the application of a spring pivot or point on which the magnetic compass-card revolves, and springs to an outward or second gimbal to the bowl; 9. By the application of the invention to electro-magnetic instruments.

Anchors.—*Mr. W. Rodger, patentee.*—These improvements in anchors have reference to those parts which are usually termed the crown, the arms, and the palms, and the object in view is, to obtain a greater amount of strength and holding power with a given weight of iron than is possessed by anchors of the ordinary construction. The additional

strength is obtained by partly making the arms shorter than usual, in proportion to the length of the shank—that is to say, about one-fourth part instead of about one-third,—and partly by their sectional form. The sectional form of the shank is rectangular at its junction with the arms, and square at the shank, close to the collar, for the stock. The sectional form of the arms is different from that of any other anchor now in use, being of a wedge form, varying in sharpness from the throat to the head of the palms. The back part of the arms is made parallel from palm to palm, and is much thicker than the front part, which is tapered in the direction of the point. The arms from the crown to the head of the palms being much broader in the direction of the strain than is usual, gives them a great increase of strength.

Mooring Buoys.—*Mr. G. F. Lyster, patentee.*—These mooring-buoys are constructed in such a manner that, instead of being attached to the mooring-chain, and serving as the point of attachment for the vessels, they act simply as a float or carrier for keeping the end of the mooring-chain above water, the latter being in no way attached to the buoy, beyond passing through an aperture formed in the same, and, when not atttached to a ship's cable, being prevented from falling through the aperture by the larger dimensions of the mooring-ring.

Submarine Lantern.—*Mr. G. W. Fuller, patentee.*—This improved submarine lantern is so constructed, that when in use, at whatever depth below the surface of the sea, it will have a pressure of air within it equal, or about equal, to the pressure of the water on its external surface; whereby the lantern may be of little strength and weight, comparatively, and easily handled while below the surface of the water.

Powder Chargers.—*Messrs. Hawksley & Bissell, patentees.*—These improvements consist in a new method of constructing the chargers of powder-flasks—that is, the appliances fixed on powder-flasks for measuring and pouring the charge of powder into guns and rifles. Hitherto there have been two chief parts in such articles, a fixed tube or cylinder, and a moveable tube with a contracted mouth. The moveable tube has had notches cut in it, and an inclined or straight slit, into which the notches upon the moveable tube have been set for use by a pin or stud inserted in the fixed tube, entering one or other of the notches in the moveable tube; there have been no means, however, of regulating the capacity of the charger to any point intermediate between any two notches. Now, this invention consists in fitting an upright parallel with the fixed tube, in connecting the moveable tube to a bar having an aperture through it, into which the upright enters, and on which it is free to slide up and down, taking the moveable tube with it. A set-screw attached to the bar on the moveable tube fixes it at any desired height on the upright. Graduated scales of grains and drams are marked on the fixed tube, and apertures are made in the lower part of the moveable tube to read the scales. In some cases the patentees dispense with the upright, and apply a set-screw to the moveable tube, to fix it at any height on the fixed tube. Another part of the invention consists in fitting a spring lid, which moves horizontally to close or open the mouth of the moveable

tube. This horizontal spring lid is also applicable to powder-flask chargers, however otherwise constructed.

PROJECTILES.—*Mr. J. Norton, patentee.*—This invention has reference to projectiles or ignition missiles suitable for igniting any inflammable body with which they may be brought into contact. Under one modification, the shell—which is made of any suitable figure externally—is charged with liquid phosphorus. This solution is prepared by dissolving phosphorus in a suitable quantity of the bisulphide of carbon, and to this solution may be added a proportion of benzole, for increasing the inflammability of the solution. The front end of the shell is made so that it may be pierced in its passage from the gun. This may be done by placing a plug in the muzzle of the gun, the inner end of this plug being pointed or made with a piercer that will perforate the shell. On the gun being fired, the shell is impelled against the pointed part of the plug, which is driven out by the force of the blow, and does not further impede the flight of the shell. In the passage of the shell the liquid phosphorus slowly escapes from the apertures, and ignites on coming in contact with the atmosphere, and continues burning until the whole of the liquid is consumed.

INLAYING GOLD AND OTHER METALS IN GLASS AND COMPOSITION.—*Messrs. Wild & Randel, patentees.*—When the patentees desire to inlay gold or any other metal in glass, they place the metal to be so inlaid within a mould, which mould is then placed at one end of a pair of pinching pliers; having melted sufficient glass to fill the mould, they compress the pliers, and the metal remains imbedded within the glass, which is then annealed, and is afterwards ready for cutting and polishing. The glass most suitable for the purpose is the kind known as Bohemian glass, as this melts at a lower heat, and takes a better polish, than any other description of glass; but when this is not to be obtained, or when they desire to produce a cheaper article, they use the common kind of English glass. When they desire to inlay gold or any other metal in the composition before mentioned, they prepare the composition by taking about four parts of glass and two parts of enamel, which, after being well pounded and mixed in a mortar, are placed in a copper mould with the metal to be inlaid at the bottom of the mould. They then place the mould on a copper plate (on which is placed a thin layer of plaster of Paris), and the plate with the mould on it is then placed in an enamelling stove, over a coke fire, until the whole is well fused; it is then annealed, and when taken out of the mould is ready for cutting and polishing.

CRICKET-BATS.—*Mr. J. Cavanah, patentee.*—These cricket-bats are manufactured with a loose handle, which handle is joined to the blade in conjunction with a spring. The loose handle is secured to the upper part or mouth of the blade of the bat by a hinge or knee-joint; attached is a spiral or flat spring, made of steel, india-rubber, or any other suitable elastic substance, fixed with metal plates and sockets to the blade and handle. The spring may be applied or attached to such portion of the blade or handle as may be found most desirable, its employment preventing the concussion of the ball stinging or jarring the hand.

Weighing Apparatus.—*Mr. N. R. Hall, patentee.*—These improvements in weighing apparatus are based on the principle of the common steelyard, inasmuch as the article to be weighed is suspended at the short arm of the lever, but differs otherwise; for instead of ascertaining the weight of an article by shifting or sliding a given weight upon the long arm until it is perfectly horizontal, the patentee allows this weighing apparatus to come to rest in any position, according as the weight of the article may draw it more or less from the horizontal line, and he then discovers the weight of the article sought by means of a hand which points to various figures representing weights, which figures are marked upon a circle. This circle is at the extremity of one end of the weighing apparatus, and at the centre of this circle or dial the hand moves or plays freely upon a stationary pin; the hand having a heavy tail end it will always maintain a perpendicular position when in use, and will therefore be directed to that number which is brought to a vertical position with the centre of the circle or dial. At the proper end for attaching the articles to be weighed there is a suitable clip with hooks for attaching the articles. When this weighing apparatus is hung or held up for use with the article properly suspended, the circle or dial will rise more or less, and one of the numbers marked upon it will be brought to a vertical position, to which number the hand will be directed, and thereby indicate the weight of the article.

Organs, Harmoniums, and Pianofortes.—*Messrs. Roberts & Naylor, patentees.*—According to these improvements, the inventors place the key-boards, keys, or manuals of organs, harmoniums, pianofortes, German pedals, and pedal claviers on springs at the front part, or they suspend the same from springs, so that when more pressure is used on the keys than is required for playing, the keys yield, and the swell-shutters or venetians open, thereby increasing and regulating the sound. Or, as a modification of the same principle, they place a spring of india-rubber or other suitable material under each key, and thus obtain the same result.

SCIENTIFIC SUMMARY.

ASTRONOMY.

Atmosphere of Sun, Planets, &c.—Professor Challis accounts for the bright band bordering the edge of the moon during solar eclipses (which was noticed by Professor Alexander in 1831 and 1860, and which is likewise depicted in Mr. de la Rue's photographs) to the refraction caused by the atmosphere of the moon. At the November meeting of the Astronomical Society, the Astronomer Royal read a paper, in which his object was to prove that no refraction could cause a change in the apparent brightness of the surface of the sun bordering on the moon's edge. He is of opinion that this luminous band arises from a mere effect of contrast, and that it is an ocular nervous phenomenon. As an instance of this, he states that if a piece of black cloth is swung between the eye and a moderately-illuminated whitish wall, that the edge of the cloth will be preceded by a broad luminous band. From the decay of the irritability of the retina, it is not so well seen by him now as formerly, when, on favourable occasions, its angular breadth was not less than two degrees. In regard to the eye-view of the photographs of the eclipse, it is stated that the explanation of the Astronomer Royal has been confirmed by some experiments made by Mr. de la Rue.

Depressions on the Lunar Surface.—On September 20, at 6 p.m., the Rev. H. C. Key, on looking at the moon with a 12-inch glass speculum, noticed that its edge did not present the usual circular form, but that it was quite out of shape; in fact, irregularly polygonal. Four sides, or plains, were distinctly seen on the illuminated limb. They could not be seen with the same telescope on September 25, but were observed by the Rev. T. W. Webb on September 30. Mr. Key is of opinion that they are not visible for more than forty-eight hours at a time, and that the best time for viewing them is from three to four days after the greatest south-east libration. The largest of the plains stretched over more than thirty-five degrees of latitude, and its deepest depression below the general level was estimated at twenty-five miles at the least. These observations were made by the glass speculum in an *unsilvered* state, and Mr. Key strongly recommends its use in this condition, not only in regard to the sun, but with the planets, especially Venus. The delicate pencilling on the surface of Jupiter was brought out with marvellous effect, and Saturn appeared as if seen in relief, the body of the planet seeming to be isolated and suspended within the rings. From the total absence of irradiation he likewise recommends this plan for observing occultations by the moon, as well as the moon itself. When at the time of new moon the whole periphery is seen, the effect of this irradiation is very apparent, the illuminated edge appearing to be a portion of a much larger circle than the rest.

Occultation of Kappa Cancri.—This star, it will be remembered, was observed by Mr. Copeland on the occasion of its occultation by the moon on April 26, to disappear in two successive jerks. Other observers, however, did not perceive anything unusual. In a communication, dated October 17, it appears, however, that Mr. Prince noticed the phenomenon described by Mr. Copeland, and states that it was not instantaneous by fully half a second. Mr. Creswick, of the Greenwich Observatory, likewise confirms Mr. Copeland's observation, but is certain that no great loss of light occurred *half* a second before disappearance. If such were the case, the duplicity of the star would still be extremely difficult, if not impossible, to detect, as the components would be little more than two-tenths of a second of space apart.

Gamma Andromedæ.—The close double star of this beautiful triple was measured by Mr. Dawes on November 12, with an 8¼-inch refractor by Alvan Clark. It has also been separated during the winter by Mr. Wray with a telescope of his own construction, and of the same dimensions. It is considered the most difficult test-object in the heavens; and as a proof of the extreme closeness of the components of Kappa Cancri, alluded to in the last paragraph, it may be stated that the distance of this close pair of Gamma Andromedæ is six-tenths of a second.

New Comets.—The fourth comet of 1863 was discovered on October 9, by Mr. Bäcker at Nauen. It arrived at its greatest brilliancy on December 8, being nearly four times as bright as when first seen. It does not appear, however, to have been visible to the naked eye. On December 16, its R.A. was $16^h\ 23^m$, and increasing, and its declination 43 degrees north. The fifth comet of the year was detected by M. Tempel, at Marseilles, on November 4, and was visible to the naked eye. Its nucleus, according to Mr. Hind, was nearly stellar. Neither of those objects appear to have been previously observed. The fourth comet arrives at perihelion on December 27. The *sixth* comet of 1863 was discovered by M. Schmidt, at Athens, in December; but an ephemeris has not yet appeared. The comet supposed to have been detected at Cheltenham, on October 15, seems to be the great meteor observed by Mr. Lowe on that evening.

New Planet.—The seventy-ninth planet of the group between Mars and Jupiter was discovered by Mr. Watson at Ann Arbor (U.S.) on September 14. It is described as of the tenth magnitude. The discovery of the eightieth planet, announced by M. Schmidt, at Athens, has been found to be a mistake; one of the asteroids already known having been reobserved.

Observations of the Minor Planets.—An agreement has been made between the directors of the observatories of Greenwich and Paris, that at the former establishment the planets are to be observed from new moon to full moon, and at the latter, from full moon to new moon. The Astronomer Royal requests to be informed of any error which may be detected in the ephemerides of the asteroids, which will be immediately published in the daily bulletin of the Paris observatory.

Earthquake on October 6.—This rare occurrence (in those islands) was noticed in a remarkable manner by Mr. Ellis, at the Greenwich Observatory, whilst observing the collimation of the altazimuth instrument—the mark fixed to the wall moving as if the latter was in motion. Mr. Hough, observing at Lord Wrottesley's observatory at Wolverhampton, felt a

rocky motion in his chair. It does not appear to have permanently affected the position of any astronomical instrument, or to have had any effect upon the time-keepers, although such displacements could be detected with the greatest accuracy. It seems that the earthquake was felt at Antigua at the same moment of time as in the British Islands.

Venus at Inferior Conjunction.—At the time of inferior conjunction of Venus on September 28, numerous observers perceived not only the faint crescent of the planet, but likewise the whole of the disc. This curious appearance, resembling that of the new moon when illumined by the earth-light, appears to have been most favourably seen by Mr. Prince, at Uckfield, between September 23 and 28. On September 30 "a phosphorescent flitting of light around the *edge* of the disc" was remarked. Capt. Noble, however, appears to have seen it as late as October 9, and Mr. Barber and the editor of the *Astronomical Register*, respectively, on October 22 and October 25. Both these observations were confirmed at the time by independent witnesses, who immediately perceived the phenomenon, without having been previously told of it. On October 6 Mr. Banks likewise observed it. It has doubtless been seen by other observers. It is very difficult to account for this phenomenon, which seems to be particular to this planet (not having been noticed in Mercury), and would tend to show that either its surface or atmosphere was self-luminous. The usual irregularities in the cusps of the planet were likewise seen on this occasion.

Small Stars in the Nebula of Orion.—Dr. Winnecke thinks it probable that some of the small stars in the immediate neighbourhood of the trapezium are variable; as he recently detected five stars which are not given in Struve's Catalogue. It has since been found that they had previously been seen by Lassell, and are marked in his map.

Eta Argus.—This remarkable variable star, which in 1843 was nearly equal to Sirius in brightness, is at the present time seen with difficulty without a telescope. Mr. Abbott, of Hobart Town, has carefully observed it since 1856, when it was still a star of the first magnitude, to the present time. In April last, on a fine clear night, with the star in the zenith, it was scarcely recognized with the naked eye. It does not appear to be at all regular in its changes. Not only is the star itself subject to change, but also, according to Mr. Abbott's observations, all the objects surrounding it. In Sir John Herschel's drawing (1838) of the nebula, in his Cape observations, the star is situated in the most dense part of the nebula. At the present time it is completely out of the nebula. Mr. Abbott likewise speaks of a great number of isolated stars, which he can see with a five-feet achromatic telescope, but which are not given in Sir J. Herschel's map. Various changes in the shape of the nebula appear likewise to have taken place.

Change of Colour in Stars.—It is suspected by Admiral Smyth, that a case of sidereal colour-changing is now going on in the star 95 Herculis. Mr. Higgins has observed the same variability, which, he says, is sufficiently palpable after intervals so short as three or four nights. In the autumn of 1862 he records their colours as apple-green and cherry-red. In April last they were respectively greenish white and pinkish white;

in May, both of a dull white; on August 1, greenish white and yellowish; whilst on August 12 they were apple-green and cherry-red. The first star showed signs of deepening colour, and the latter changing from yellow to red more rapidly.

Distance of Sun from the Earth.—Professor Hansen has given a more accurate statement of his calculation of the sun's parallax from the lunar theory. M. Hansen was the first who (in 1854) showed the necessity of increasing the solar parallax as deduced by this means, and from his new calculations finds the value of 8″·9159, which agrees closely with the late determinations of Le Verrier, Stone, &c.

Lunar Nomenclature.—Mr. Birt continues to meet with several craters in the moon, which have been passed over or unnamed by Beer and Maedler. He follows the principle of those astronomers in naming them after distinguished *savans*, mostly those of the present day.

Observations of Sun at Rising.—Sir Andrew Lang gives some measurements taken at St. Croix, West Indies, to determine the refraction. From the mean of eighteen observations he determines the refraction and parallax at the horizon as 32′ 14″. In 1860 he determined the number of spots as 274; in 1861, as 226; and in 1862, as 148. From September 12 to 22 of the present year there was not a spot on the disc. The same happened from August 24 to September 9, which he states is an extraordinary occurrence.

Meteors.—During the past quarter many magnificent meteors have been observed; one, in particular, was seen over a vast extent of country, and the observations may be numerous and accurate enough to determine its height and course.

Variable Star.—A variable star, whose position is $20^h\ 5^m$ of R.A. and 15° 13′ of north declination, was discovered in the autumn at Mr. Worthington's observatory. It appears to change rapidly in brightness, having a period of about four months, according to Mr. Baxendell. He states that it was at its minimum on August 24, 1863, when it was of the 11·3 magnitude; and at its maximum on October 25, 1863, when it had increased to the 8·9 magnitude.

Brightness of the Sun.—Making use of a method somewhat similar to that of Huyghens for determining the brightness of Sirius, but with more delicate apparatus, Mr. Alvan Clark has compared the light of the sun and Alpha Lyræ. He concludes, that if the sun were removed to 103224, its actual distance, it would still be as bright as the star in question.

Nebulæ.—Mr. Lassell continues his researches on the forms of nebulæ with his splendid reflector at Malta. His latest discovery in this respect is on a planetary nebula situated at R.A. $20^h\ 56^m$, and 11° 56′ of south declination. In the interior there is a brilliant elliptic ring, extremely well defined, which does not appear to have any connection with the surrounding gaseous or gauze-like envelope. As this object is favourably visible in those latitudes, it will doubtless be looked at.

Catalogue of Stars, &c.—A continuation of Weisse's valuable work—the reduction of Bessel's "Zone Observations"—has appeared. The present publication contains the stars included between 15 and 45 degrees of north latitude. A new edition of Sir J. Herschel's "Outlines of Astronomy" is

announced. Mr. Hind has published his "Introduction to Astronomy." A German astronomical society has been inaugurated: the first meeting was held at Heidelberg on August 28.

BOTANY AND VEGETABLE PHYSIOLOGY.

Two Forms of Plants growing under the same Conditions.—Dr. John Edward Gray, F.R.S., of the British Museum, has lately recorded the fact that occasionally upon the same tuft, flowers of quite opposite colours may be found. This year, at Watfield, he found tufts of the *Anemone nemorosa*, on which were flowers some of which were purple and others of the normal white colour; and although both were in the same tuft, the purple variety was characterised not only by the colour of its flower but by its darker foliage and narrower petals. The plants of *Primula vulgaris* exhibit similar variations, being sometimes found differing in colour, although residing in the same locality, and apparently without being influenced externally in any way sufficient to account for the difference. The colour of the primroses found near Broadhaven in Pembrokeshire is usually a pale lilac, so that, as Dr. Gray observes, "to ask for a yellow ribbon as primrose-coloured would be a misnomer." In the case of the wood-sorrels, too, pink flowers are sometimes seen among the natural white ones. This has been recorded by Dillenius. Dr. Gray has observed this phenomenon of variation, also, in *Lamium album* and in *Anthriscus sylvestris*, one of the Umbelliferæ.—*The Journal of Botany, British and Foreign*, October.

Inflammable Gases developed by Plants.—It was first observed by Linnæus' daughter, that when she approached the flowers of *Dictamnus albus* with a lighted taper, a flame was kindled round the petals, without, however, affecting their structure. The observation, however, was not confirmed, and so it remained till recently, when Dr. Hahn conducted some experiments with a view to ascertain the truth or falsity of the statement. At first he supposed it was necessary to make the attempt to kindle this lambent flame in warm weather; but he has since discovered that external temperature has nothing whatever to do with the phenomenon. On applying the flame of a candle to some freshly opened flowers, there was no ignition of gases, but the moment it was brought near a faded blossom there was produced "a reddish, crackling, strongly sooting flame, which left a powerfully aromatic smell and did not injure the peduncle." When the faded and fresh flowers were comparatively examined, it was discovered that there was a series of small glands in both, but these were much more fully developed in the former than in the latter. These glands secrete a peculiar ethereal oil, to which, no doubt, the flame and the perfume of incense are due.

Goethe's Essay on the Metamorphosis of Plants.—This most philosophic achievement of the great German poet is really the foundation of all our modern ideas of the homologies of the various organs of plants. It has been admirably translated by E. M. Cox, and appeared in its English garb in the November number of the "Journal of Botany," to which we beg to refer our readers for further particulars.

Distribution of Trichomanes radicans.—The Killarney fern, as it is termed in this country, is far more generally distributed than is usually imagined. In some of our popular works it is stated that the only stations for it in the British Islands are Yorkshire and Kerry. This idea is incorrect. The late Professor Kinahan discovered it growing in profusion in the counties of Wicklow and Waterford, in Ireland, and now we have Mr. W. Gast's authority for stating that it has been found in the northern half of the Scotch island of Arran. It may be remarked, that owing to the hyper-enthusiasm of botanists, this plant is no longer to be found growing in Killarney.

Leaf-Cells of Hymenophyllum and Trichomanes.—Professor Gulliver states that there is hardly any distinction to be drawn between the leaf-cells of *Trichomanes* and those of *Hymenophyllum Wilsoni*, although the differences between *H. Tunbridgense* and each of the others are very well marked.

Relation between the Colour of Leaves and Decomposition of Carbonic Acid.—In opposition to the views of M. Corenwinder (*vide* POPULAR SCIENCE REVIEW for October, p. 103), M. Cloez states that, although the leaves of certain plants appear to be of a reddish or brownish tint, if they be examined carefully, it will be seen that they always contain, intermingled with the ordinary colouring matter, but in an isolated state, a quantity of green substance. His experiments tend to prove that it is in virtue of this material that these leaves decompose carbonic acid, as demonstrated by M. Corenwinder. The apparent exception to the rule is that of *Atriplex hortensis*, which, according to Saussure's experiment, produced seven or eight times its volume of oxygen in four or six hours, although all its leaves are red or purple. That this plant does decompose carbonic acid, M. Cloez admits, having seen it do so himself. He asserts that in the tissue of even *its* leaves there exists a certain quantity of green matter; but this is masked by the presence of a violet-red principle, which may be isolated by chemical means. He took a common garden species of *Amaranthus*, and cut the leaves, which are green, red, and yellow, in such a manner as to separate the different coloured parts from each other. These were now placed in water whose gases had been expelled, but which was charged with carbonic acid, and then submitted to the action of light. It was found that *the green parts alone produced oxygen*, whilst the other portions (red and yellow) did not furnish the slightest trace of the gas, even after twelve hours' exposure to the sun. The following were the conditions and results of the experiment:—Twelve grammes of the leaves were taken and were placed in a flask of about two litres capacity, previously filled with water containing a small quantity of carbonic acid. The flask was provided with an exit tube, and after twelve hours' exposure, 245 cubic centimetres of gas were developed, whose composition, in 100 volumes, was that beneath:—

Oxygen	85·64
Carbonic Acid	1·24
Nitrogen	13·12
	100·00

—*Comptes Rendus*, Nov. 16th.)

Anatomy of the Cytineæ.—The results of M. Chatin's investigations into the anatomy of these plants may be thus epitomized:—1. Tuberous tissue is found in the rhizome (*Hydnora*). 2. The cellular tissue is disposed in three very distinct concentric zones (rhizome of *Hydnora*). 3. The cortical fibres are absent, and the fibro-woody tissue is exceedingly delicate. 4. The vascular bundles are scattered, in the flat stem of Hydnora, as in the orobanchs and in monocotyledons. 5. The vessels are of two kinds, and are not marked by constrictions, as asserted by Meyer. 6. The two forms of direction of the cells in the anther tissue are represented here, in Hydnora and Cytinus.

Chemical Composition of the Brazil Banana.—M. Corenwinder has just published an analysis of this fruit, which almost of itself alone constitutes the food of whole populations in the neighbourhood of the equator. Boussingault had already given its *qualitative* constitution, but here we have the *quantitative*:—

Water	73·900
Vegetable albumen	4·820
Cellulose	0·200
Fatty matters	0·632
Cane and other sugars, organic acids, pectose, and traces of starch	19·657
Phosphoric acid, lime, alkalies, iron, chlorine, &c. ...	0·791
	100·000

The nut had, of course, been previously removed from its husk, which was specially analyzed, when its ash was found to contain nearly 48 per cent. of carbonate of potash and 25·18 of chloride of potassium.

Disease of the Colza Plant.—A very formidable malady has of late years attacked the cultivated rape plants of Caen, and threatens to diminish the commercial supply of oil. The disease has been very carefully studied by M. Isidore Pierre. He selected fifteen plants of both kinds, healthy and unhealthy, and taking two leaves from each specimen, he compared the normal with the pathologic forms; from this he was enabled to conclude: (1) That the malady prevents the development of organic matter in the leaves which have been attacked. (2) That a comparison of equal weights (dry or green) of both forms shows an excess of about 20 per cent. of nitrogen in the unhealthy leaves. (3) The latter are also richer in mineral matters, and especially in phosphoric acid and lime, of which there are about 80 per cent. more than in the healthy leaves. (4) The tainted leaves also possess more soda than the normal ones. (5) In equal weights the two varieties contain about the same proportion of salts of potash. In estimating the total weight of the substances contained by each leaf, his results are more interesting. Thus he proved: (1) That the quantity of nitrogen in the tainted leaves is one-fifth less than that of the healthy leaves. (2) That the total weight of organic matter is about 50 per cent. less in the unhealthy leaves than in the same number of healthy ones. (3) That the total weight of mineral matters in the unhealthy leaves is about one-sixth less than that in the same number of healthy leaves. (4) That the unhealthy leaves contain about one-sixth more phosphoric

acid than the same number of healthy ones. (5) That the diseased leaves contain about one-eighth more of lime than the same number of healthy leaves. (6) The unhealthy leaves contain only six-tenths of the quantity of potash contained by the same number of normal specimens. The most important result of all these investigations is evidently the discovery that the diseased leaves have a far greater supply of *lime* and phosphoric acid than the healthy ones, and are also richer in nitrogenous principles.

Salt as a Remedy for the Vine Fungus.—It has been stated by M. Druelle, in a note to the French Academy, that the development of the oïdium or fungus, which is so destructive to the vine-crop, may be prevented by the following process: about the month of November or December a deep hole is dug close to the root of each vine, and about half a kilogramme of unrefined sea-salt is placed in it. The result of this simple measure is, that the vine is preserved from the ravages of this destructive fungus.—*Comptes Rendus*, vol. lvii. No. 14.

A new Acid found in the Bark of Larch.—In a paper in the "Philosophical Transactions," Dr. John Stenhouse, F.R.S., describes, at some length, the nature, properties, and mode of isolation of this new acid, which he proposes to term Larixinic acid. After it has been purified by sublimation, larixinic acid forms beautifully white crystals, often more than an inch in length. It seems to be peculiar to the larch (*Pinus larix*), for Dr. Stenhouse has been unable to obtain a trace in it of the bark of the spruce fir (*Abies excelsa*), or in that of the Scotch fir (*Pinus sylvestris*). Its acid properties are exceedingly feeble, if not doubtful, on which account its discoverer suggests that it might be termed *larixin*.

Formation of Oil in Olives.—M. de Luca's observations lead us to believe that the growth of the fruit in this plant takes place during the whole period of vegetation, but that the pulp and heart do not continue to increase up to the same period. For example, the latter, which is the first part to be developed, is completed about the end of August; but the pulp goes on growing till the fruit is quite mature. The quantity of water varies with the period of time; thus, whilst in the early stages of growth it is as much as 70 per cent., we find when the fruit is ripe that it has been reduced to about 25 per cent. On the contrary, the fatty matter, which is small in quantity at first, becomes extensively developed as the fruit approaches maturity. It is worthy of notice that in proportion as the heart ceases to grow the fatty matter is formed.—*Memoir read before the French Academy*, Sept. 14.

Vascular System in Plants.—The presence of the vessels included in this system is denied by M. Lestiboudois in a late memoir read before the Académie des Sciences. He contends that plants do not possess a vascular system like that of animals, the office of which is to transport and distribute the nutritious juices. The spiral vessels, even, are devoid of this quality; and although they do occasionally constitute capillary tubes, yet this property is not a permanent one. The spiral vessels are closed at their extremities, and any communication which takes place from one to the other is purely accidental. From their length they fill the office of channels, but they only diffuse fluids in so far as the permeability of their

walls permit. The cortical fibres and tubes are similar, or rather they are modifications of the same structure. They also are closed at their ends, and pass insensibly into cells; liquids alone can traverse their walls. The liquid they enclose cannot properly be termed latex, for the latter term has been applied to liquids of quite a different character. Neither, on the other hand, can the tubes themselves be termed laticiferous vessels, for this expression is also applied to another class of canals. It seems advisable to reject the expressions altogether, as they are calculated to lead to much confusion. In plants, each individual portion performs its own functions; in each cell the phenomena of cyclosis, and the formation of nutritive compounds take place, each allows the elaborated fluids to pass through it for its own purpose, and then transmits them to its neighbour; and in this manner the necessity for a vascular system is removed.—*Comptes Rendus*, lvii. No. 1.

Observations on Raphides is the title of a short article by Professor Gulliver, in the November number of the "Annals of Natural History." The writer conceives that the description of a natural order cannot be considered complete till it embraces a notice of the presence or absence of these peculiar structures. He proposes that the term *raphidiferous* be in future employed to designate a natural order including species which possess raphides. In the *Onograceæ*, these crystals are so well marked, that they may be detected even in the seed-leaves. Even in the ovules and their coats, and in the placentæ, these crystals may be found abundantly, whilst they are not present in any of those parts in plants of a kindred group. The *evening primrose* order may be regarded as the type of raphidiferous vegetables, as the crystals may be found in every portion of the plant, embryonic and adult. In the sketch which accompanies Professor Gulliver's paper, the raphides of the fuchsia's ovule are very well represented. In the natural orders Dioscoreaceæ, Araceæ, and Asparagaceæ, raphidic crystals are well seen also.

Literature of Raphides.—Dr. Lankester has contributed a valuable paper on the above to the October number of the *Quarterly Journal of Microscopical Science*. It is really a history of what has been done toward explaining the use and distribution of these crystals. We find that so early as Malpighi's time, raphides had been observed in plants, and that at later periods they engaged the attention of Quekett, Lindley, Rainey, Gulliver, Schultz, Schleiden, and Dr. Lankester himself. Almost all plants contain acetate and malate of lime, dissolved in the sap; also citrate, tartrate, and oxalate of lime, either in the solid form or in solution. The writer suggests that even the soluble salts of vegetable juices might easily be identified by the slow evaporation of the latter and microscopic examination of the deposit. It is strange that notwithstanding the intense acidity of the oxalics, no crystals of oxalate of lime can be detected in this plant. "The acicular crystals to which the name raphides has been more particularly applied, have been often described as having the same composition as the larger single and compound crystals. They are prismatic in shape, and lie together in bundles of from twenty to thirty in a single cell. They are sometimes enveloped in a gummy matter, which on being moistened distends and bursts the cell in which they are contained, and

the crystals escape at both ends; such cells have been called *biforines*." Twenty-three orders of Dicotyledons and nine of Endogenæ are enumerated as being among those possessing raphides. Dr. Lankester's paper should be consulted by all who are about to undertake the study of these crystalline formations.

CHEMISTRY.

A new Oxide of Copper has been discovered by H. Rose and described by him in "Poggendorff's Annalen," No. 9. His communication, which the reader will find given at some length in the *Chemical News* of Nov. 28, shows that, when the protochloride of copper (which is procured by adding to the sulphate a solution of protochloride of tin to which hydrochloric acid has been added) is placed while moist in a dilute solution of protochloride of tin in hydrate of potassa, the white chloride is changed into a green body, which however is reduced to metallic copper if a less dilute alkaline tin solution be employed. This green body is a new oxide, lower in the series than the familiar sub-oxide, into which latter it is converted on access of even a limited quantity of air, and eventually into the bluish protoxide. It is exceedingly difficult to obtain the new compound, because on the one hand it is very oxidisable, and on the other equally reducible to metallic copper. This compound of the metal with oxygen has been styled by its discoverer, *Quadrantoxide of copper.*

Another Test for Nitric Acid.—At a late meeting of the Chemical Society (Nov. 5th) a paper was read by Dr. Herman Sprengel detailing the results of his experiments on this subject. He does not consider that the ordinary tests, and especially the starch and iodide of potassium, ever can be much relied on. His method depends on the formation of coloured bodies, which takes place whenever nitric acid is brought in contact with certain phenyl compounds. The test-solution consists of phenyl one part, water two parts, and sulphuric acid four parts. The phenyl is first dissolved in the acid and then the water is added as a diluent. The suspected solution is first evaporated to dryness in a water bath, and then a portion of the dried residue is moistened with the test-solution, when if nitric acid is present the liquid will assume a brownish tint, which becomes yellow on the addition of ammonia. This test is so delicate that the one-six-millionth part of a grain of nitric acid may be detected by it. The discovery is in part due to Laurent, but the application is wholly Dr. Sprengel's. The author's statements were confirmed by Dr. Odling's observations.

The History of Thallium.—Mr. Crookes continues his investigations in this direction, and with what success is shown by his numerous additions to the chemistry of this new metal. Among the salts which have been recently under observation we may mention those of the *chromates, sulphates, carbonates, phosphates, nitrates,* and *perchlorates,* all of which we may almost say have been exhaustively treated of.

Siliciuretted Hydrogen.—This novel and important compound of hydrogen and silicon is produced when another new substance, silicide

of calcium, is acted on with dilute and cooled hydrochloric acid, and the scales resulting from this process are heated in a tube. These scales, which are of a nacreous colour, and which are separated from the mixture of silicide and hydrochloric acid by means of filtration, and then washed and dried in a vacuum over sulphuric acid, burn spontaneously on coming into contact with air, and leave a deposit of brown silica. The action of the hydrochloric acid on the silicide is much modified by the influence of sulphurous acid, although the latter has of itself no effect on either the silicide or silicon. When a large excess of aqueous sulphurous acid plus a small quantity of dilute hydrochloric acid is poured on powdered silicide, the latter is quickly changed, without any evolution of gas, into a reddish-brown substance, which is composed of copper-coloured scales. This new substance, when prepared, dried, and heated in the air, burns like gunpowder, and when enclosed in a tube and heated, it explodes, giving off an odour of sulphuretted hydrogen. When heated gradually it gives off sulphuretted hydrogen without exploding; and when placed in water, sulphuretted hydrogen is also formed, owing possibly to the formation of sulphide of silicium. These novel compounds have been discovered and investigated by M. F. Wöhler, who details his observations in the *Annalen der Chimie und Pharmacie* for September, 1863.

The New Notation.—The modification of Berzelius's views proposed by Gerhardt, and introduced into this country by Williamson, Odling, and others, has been rather severely analysed in a communication of Mr. Waterston's to the *Philosophical Magazine* (October). The writer considers that now fashionable scheme in great measure an empirical one, and that so-called rational formula merely temporary, inasmuch as there may be several for an individual body; that they are, in fact, possibilities; chemical evidence to determine the correct one being as yet insufficient. He considers that the decomposition of water by potassium does not indicate that the aqueous molecule is composed of two atoms of hydrogen, as he believes that in the experiment referred to, two molecules are really affected. The dynamical theory of heat and gases has not been brought to bear in an adequate manner upon the theory of chemical combinations. In conclusion, the writer observes: "Such considerations must enter into any system of classification of chemical compounds that is not quite artificial and arbitrary. To include under the same type a liquid of which the elements are in a burnt condition, with another the major part of which is in an unburnt condition, is simply to ignore the dynamical theory of heat, to reject as a guide a principle that has never failed to yield rich returns to those who have resigned themselves entirely to its guidance in the study of Nature."

Explosive Gases of Gunpowder.—These are not, as some suppose, related to the mode in which combustion takes place, but are directly dependent on the composition of the powder. In such powder as Bunsen's, which contains nitrate of potash in large quantities, as much as four per cent. of this substance is found in the residue. As a rule, it may be stated that ordnance powder develops a greater volume of explosive gases than that employed for sporting purposes. Hence, it is easy to understand that it is

far more readily ignited than the latter. In the first form, the carbonic oxide amounts to *ten* per cent., but in the second it does not extend beyond *three* in the hundred. The prevailing belief that the results of the explosion of gunpowder are carbonic acid, nitrogen, and sulphuret of potassium, is quite erroneous, and unsupported by the conclusions to be drawn from accurate analysis. The following compounds have all been detected as products of combustion :—*Sulphate, nitrate, hyposulphite, and carbonate of potash; sulphide and sulphocyanide of potassium, oxygen, hydrogen, nitrogen, charcoal, and sulphur; sesquicarbonate of ammonia, carbonic acid, and oxide; marsh gas, and sulphuretted hydrogen.*—L. von Karolzi, in *Poggendorff's Annalen.*

Mauveine is a term which has been proposed for a new base, by Mr. W. H. Perkin, in a paper lately read before the Royal Society. It is prepared by adding a solution of hydrate of potassium to a boiling solution of commercial crystallized mauve. The latter immediately assumes a purple colour on the addition of acids, and on standing deposits a crystalline body, which, after being washed with alcohol and then with water, appears as a nearly black glistening substance ; this is the base for which the new term has been devised. It is soluble in alcohol, forming a violet solution, but nearly insoluble in ether and benzine. It decomposes ammonia salts with facility. Its analysis gives it the formula—

$$(C=12) \text{ of } C_{27}\ H_{24}\ N_4$$

The following salts of this base have already been obtained and investigated :—*Acetate, carbonate, hydrochlorate, hydrobromate, hydriodate,* and double salts, with *gold* and *platinum.* Mr. Perkin is now engaged in experiments with a view to ascertain the replaceability of the hydrogen, in order to throw some light on the constitution of this base.

Common alcohol and alcohol of olefiant gas, though very generally believed to be substances which, though analogous, are still very distinct in regard to characters and reactions, have been shown by M. Berthelot to be identical bodies. There is no distinction physical or chemical between either these alcohols or their ethers. The ethyl-sulphate of barytes obtained from ordinary alcohol is exactly the same as that derived from the alcohol of olefiant gas ; but this is not all. When the olefiant alcohol is treated with chromic acid, it gives rise to ether and acetic acid, which are in no way distinguishable from those produced in a similar manner from ordinary alcohol.—*Comptes Rendus,* Nov. 9th, 1863.

Action of Nascent Hydrogen on Arsenic.—All our readers are familiar with the fact that acids disengage hydrogen from water in the presence of zinc or iron, and that when this gas comes in contact with solid arsenic, a new compound is generated which contains both substances [$As\ H_3$]. There is, however, a decided exception to this rule in the case of nitric acid and its derivatives, which, in giving rise to ammonia, cause a solid and not a gaseous hydruret of arsenic to be formed, whose formula is, $As_2\ H_1$, and which is either deposited on the zinc, or floats in flocculi through the liquid. This is the case not only when nitric acid is present, but when the solution contains any quantity of a nitrous compound. There are two obstacles to the formation of the solid body : the presence of such metals, as lead, which coat the zinc, and of organic matter. It

follows from the foregoing, that in judicial inquiries Marsh's test cannot be relied on, inasmuch as it is liable to a twofold error. Thus, if either from the sulphuric acid employed, or even from the suspected organic liquid, the smallest quantity of nitrous compound is developed, the solid and not the gaseous hydruret will be formed. Or again, if the sulphuric acid itself contains arsenic, an error of a common kind must be fallen into. The latter, however, has been known for some time.—*See* Blondlot's *Mémoire* in *Comptes Rendus*, lvii., p. 596.

Non-existence of Wasium as a Simple Body.—Wasium was thought by M. Bahr to be constantly present in Norwegian *orlhite;* this idea has been refuted in a note to the Academy of Sciences (Nov. 2nd), by M. J. Niclès. The latter chemist asserts that wasium is not a simple body, and that its supposed oxide is nothing more than that of Yttrium, coloured most probably by a little oxide of Terbium. This assertion is fully borne out by reference to the following reactions which take place in the two instances:—

Reagent.	*Wasium.*	*Yttrium.*
Oxalic acid	...white precipitate	white precipitate.
Ammonia	an imperfect precipitate ...	an imperfect precipitate.
Caustic potash ...	white precipitate insoluble in excess	white precipitate insoluble in excess.
Sulphate of potash	crystalline white precipitate	crystalline white precipitate.
In the oxidising and reducing flame + borax.	transparent globule	transparent globule.

Volumetric Relations of Ozone.—It is satisfactory to find that the researches of our countrymen Tait and Andrews, though not universally accepted, have been fully corroborated by some recent researches of M. J. L. Loret. The latter, in a memoir presented to the Académie des Sciences, on the 5th of October last, details the results of a series of investigations upon this subject, and confirms, on all points, the conclusions of the English chemists. In order to test the alteration of volume in ozone under different conditions, he experimented on it with oxidisable substances, such as iodide of potassium and arsenite of soda, by means of heat and with caustic potash, whose action he finds to be distinct from that of oxidisable bodies. Caustic potash affects ozone somewhat in the same way as heat, and produces an unquestionable increase of volume. He explains the results obtained, by supposing that *each molecule of ozone contains more than one atom of oxygen.* Many chemists suppose that the ordinary molecule of oxygen in the gaseous state is formed by the union of two atoms, and is consequently an oxide of oxygen—O O. If this view be adopted, and it be supposed that ozone is an allotropic form of oxygen, then it follows that the molecule of ozone has a different arrangement of its parts. Experiment goes to show that this molecule is not composed of a single atom of oxygen, but that it consists of more than two atoms. It is possible that one molecule of ozone is composed of *three* atoms of oxygen; so that, in fact, ozone is a binoxide of oxygen. The oxidising power of ozone, its constant volume when treated with oxidisable bodies, its expan-

sion under the influence of heat, and its contraction when acted on by electricity, are all readily explicable on this hypothesis. As there are no facts to prove that the number of its atoms is three rather than four or five, its density must be known before any certain conclusion can be drawn on this point.

Characters of Rain-Water.—M. Robinet finds that his experiments, conducted through a period of eighteen months—from March, 1862, to September, 1863,—enable him to draw the following conclusions :—(1.) Disturbance of the atmosphere does not seem to influence the quantity of fixed matter dissolved in rain-water. (2.) The proportion of fixed matter is not influenced by day or night. (3.) Frequently, after prolonged droughts, there is found a large quantity of fixed matter, but this is not constant. (4.) If successive portions of water from the same shower, or even the water of successive showers, be examined, it will be found that there is less fixed matter in the later than in the earlier collected portions. (5.) Paris rain-water contains chiefly sulphate of lime and an imperfectly known form of organic matter; the proportion of sulphate of lime being about 20 grammes to the cubic metre. (6.) Rain-water is more liable to froth when shaken than any other form known. (7.) When nitrate of silver is mixed with Paris rain-water it is found to produce a reddish colour of various hues, and a deposit of a garnet-tint which contains the silver. (8.) The nature of the substance which produces this phenomenon is unknown.—*Comptes Rendus*, lvii. No. 10.

Chemical Composition of Corn found in Pompeii.—The corn which was discovered among the ruins of the buried city has been analysed by M. S. de Luca, who has presented his second memoir to the French Academy. After eighteen centuries of exposure to external influence it would not be surprising if the grains had been completely destroyed. Such, however, is not the case, and although there is an absence of the proper organic elements still the mineral constituents are present, the original form is preserved, and each grain is of a blackish-brown colour, and weighs about 18 milligrammes. In resuming his remarks, M. de Luca observes, "The corn of Pompeii, although preserving its primitive form, has lost all trace of organic materials, and contains neither gluten, starch, sugar, nor fatty matter. The result of decomposition is such, that there is still found all the nitrogen and nearly all the carbon of ordinary corn; but the mineral matters, which I detected in large proportion, were probably due to water, which, holding them in suspension, deposited them in the carbonized, permeable and amorphous portion of the grains."

Action of re-Agents on Minerals.—M. Kuhlmann, following up his researches on "the preservation of materials employed in building and ornamentation," has delivered a lecture before the Academy on the above subject. *Oxygen*, he says, gives a brown or bright red colour to green or yellow jaspers; it renders transparent, smoked quartz, amethysts, and topazes; it gives a paler hue to the emerald and sapphire. It deprives red and yellow cornelian of their colour, but their silica becomes whitish from losing its water of crystallization. *Binoxide of nitrogen* produces nearly the same effect as oxygen. *Chlorine* is like the preceding gases. The diamond, ruby, and sapphire alone resisted its action. By chlorine and

hydrochloric acid gas, agates and jaspers, coloured green and yellow, were converted into brownish stones. The action of dry hydrochloric acid is to convert the calcareous veins which traverse minerals, into chloride of calcium; which, being soluble in water, we are thus enabled to make, as it were, an anatomical examination of certain compound minerals, and in this way to simplify their formulæ. *Hydrogen*, by reducing the oxide of iron in certain red marbles and agates, causes these latter to assume a blackish colour. It reduces malachite to the metal state, and blackens lapis-lazuli. Ammonia gives red granite a blackish colour, the same as bloodstone. It reduces malachite, as above, and converts pyrolucite into protoxide of manganese, with the production of nitric acid, the protoxide still preserving the crystalline form of pyrolucite. *Cyanogen:* this gas acts as an energetic de-oxydiser; it removes the colour of amethyst, and yellow and red cornelian, leaving a deposit of carbon in the fissures of these stones. It also blackens red agates by reducing the oxide of iron. *Hydro-sulphuric acid* does not affect the smoked or yellow diamond, nor the sapphire. It gives the ruby a violet tint. Red quartz and amethyst are discoloured by it. Red cornelian is discoloured and loses its transparency on account of the formation of hydrates; the turquoise is blackened, and marbles, granites, and agates, whose colour is due to oxide of iron, are similarly affected. M. Kuhlmann obtained the foregoing results by enclosing portions of the minerals in a porcelain tube, heating this to a temperature which, though elevated, was not sufficient to produce decomposition of the minerals, and then causing a stream of the gas in question to play upon the latter.—Vide *L'Institut*, November 11, 1863.

GEOLOGY AND PALÆONTOLOGY.

Air Breathers of the Coal Period in Nova Scotia.—In a late number of the "Canadian Naturalist and Geologist" we find a very valuable paper with the above title. It is from the pen of J. W. Dawson, F.R.S., a man well known for his many additions to the science of Geology: he describes four species of Hylonomus, one of Hylerpeton, two of Dendrerpeton, one of Baphetes, and one of Eosaurus, all of which belong to the class reptilia; and he also describes two invertebrata, one a mollusk, *Pupa vetusta*, and the other a centipede, *Xylobius Sigillanæ*. The coal measures of Nova Scotia like those elsewhere, present ample evidence of brackish and fresh-water conditions. But in this respect they are not exceptional. "It is true that, in Great Britain, evidences of marine life do occur in the coal measures; but not, so far as I am aware, in circumstances which justify the inference that coal is of marine origin." The writer mentions that at Fort Lawrence we meet with a forest, growing in upland soil, forty feet below high-water mark and covered with mud, containing living *Myas* and *Tellinas*, but we are not justfied in supposing that this forest grew in the sea. Dr. Dawson is not content with mere descriptions of the air-breathers, but endeavours to strike a blow at the advocates of the doctrine of "origin of species by natural selection." For example, he supposes

that the air-breathers of the coal period are really the first species of their several families and then goes on to say,—"Looking at them from this point of view, we shall first be struck by the fact, that they belong to all of the then great leading types of animals, which include our modern air-breathers—the Vertebrates, Articulates, and Mollusks. This at once excludes the supposition that they can all have been derived from each other, within the limits of the coal period." * * * * * "Again, our reptiles of the coal do not constitute a continuous series, nor is it possible that they can all, except at widely different times, have originated from the same source." The peculiarity of Dr. Dawson's reasoning is, that it commences with a *petitio principii*, and that apparently the Doctor is unaware that negative evidence of the kind produced neither supports his own doctrine nor militates against that of Mr. Darwin.

The Earth's Temperature in Palœozoic Times.—A very beautiful hypothesis has been framed by Mr. Sterry Hunt, F.R.S., to account for the increased temperature of the earth's surface in former Geologic times. Adopting Professor Tyndall's views on the subject of absorption of heat, he shows that during Palæozoic times the presence of large quantities of carbonic acid in the atmosphere was sufficient to prevent the radiation from the earth of the heat derived from the sun, and thus to increase the temperature of our planet. Dr. Tyndall has shown that, heat from whatever source, passes through oxygen, hydrogen, and nitrogen gases, or through dry air with nearly the same facility as through a vacuum. Like rock-salt they allow of the transmission of heat; glass, however, and certain other substances, although allowing heat to travel through them from luminous bodies, prevent its radiation from non-luminous ones. There are some gases which also possess this property; thus the absorption of heat from a body at a temperature of 212 Fahr. is by vacuum 0, that by dry air 1, that by carbonic acid gas 90, that by marsh gas 403, that by olefiant gas 970, and that by ammonia 1195. So long as the earth is surrounded by a stratum of vapour, so long will radiation from it be retarded; but during long nights the radiation into space causes the precipitation of a large quantity of this watery vapour, and so the protective shield is lost. However, we have every reason to believe that, during the earlier geological periods, all that carbonic acid which we now have in our various limestones, and as carbon in our coal formations, was distributed through the atmosphere. This having been the case, it is evident that the quantity of heat radiated from the earth during these epochs must have been vastly less than that which passes away in our times; hence the temperature must also have been considerably higher, thus explaining why a vegetation like that of the tropics once existed within the frigid zones. In fact, the carbonic acid surrounded the earth like a huge protecting dome of glass.—Vide *Canadian Naturalist and Geologist*, August, 1863.

Brachiopods new to the Lower Greensand of the Isle of Wight.—Mr. E. Ray Lankester records the presence of two *Terebratulæ* in the lower greensand beds of the Isle of Wight, which have never before been found in these strata. He identifies them with *T. Moutoniana* of D'Orbigny, and *T. depressa* of Lamarck. "The first is somewhat oval in shape, depressed and elongated; surface entirely smooth." The second has lenticular valves

"beak much produced, foramen very large and circular, deltidium large," and only one specimen was obtained by the discoverer. In addition to the foregoing, a very curious, deformed specimen of Morris's *T. Celtica* was found, it has a produced and incurved beak, with a deep groove running along the middle of the perforated valve, the smaller valve being marked by a corresponding elevation. Mr. Lankester, in contrasting the number of forms found in our British lower greensand strata with that of the continental beds, observes, "There is no reason why such forms as *T. diphyoïdes*, *T. hippopus*, and others associated with a common British species, *T. sella*, in the Upper Neocomian or Urgonian beds of France, should not be met with in this country." We agree with him in thinking that, geologists should not be content with such negative evidence, but should hope to fill the empty spaces in our lists, in course of time.

Anatomy of Plesiosaurus Cramptoni.—A splendid fossil which lay in one of the houses of the Zoological Society of Ireland, from the year 1852 till very recently, has at length fallen into the hands of the Royal Dublin Society, and has been made the subject of an admirable memoir by Messrs. Carte and Bailey. The fossil was originally obtained from the liassic beds, near Whitby, in Yorkshire, on the property of the Marquis of Normanby, by whom it was presented to the late Sir Philip Crampton, of Dublin. A rough section of the beds in which the specimen was found is attached to the memoir, and from it we perceive that the fossil lay at a depth of 110 feet from the surface, in a stratum of aluminous shale, which itself was covered, from below upwards, with a layer of cement nodules, one of inferior oolitic ironstone, one of marl, and one of sandstone. The skeleton measures, in the line of its vertebræ, twenty-two feet two inches, and in width fully thirteen feet. It lies in the prone position, resting on the central surface, and has the head and neck slightly inclined to the right side. The skull has been almost entirely cleared of matrix, and, with the exception of the zygomatic bones, is quite perfect. The vertebral column has in part fallen over to the right side, so that the lateral surfaces of the conical vertebræ are distinctly seen with their large neurapophyses, and occasionally with their peculiar hatchet-shaped ribs. The bodies of the dorsal vertebræ are almost entirely concealed, but the massive processes project above the surface. The caudal portion of the spine has suffered dislocation, especially that portion of it which joins the sacrum. The ribs are remarkably well seen, spreading out nearly in their natural position. The pectoral extremities pass out at right angles with the column, and one of the ventral extremities is placed likewise, the other being more parallel with the spine. The total number of vertebræ is *ninety-one*, those of *P. Zetlandicus* and *P. Macrocephalus* being respectively *ninety-six* and *ninety-five*. The teeth are like those of a crocodile, irregularly arranged, and embedded in sockets. There are about 120 teeth in *P. Cramptnoi*, the largest of them measuring an inch in diameter at its base. The fossil has been named in compliment to the distinguished Irish surgeon who presented it to the Society, *P. Cramptoni*. The communication of Messrs. Carte and Bailey has appended to it a series of well-executed lithographs, which certainly in point of style equal anything we have hitherto seen in this way.—Vide *Dublin Quarterly Journal of Science*, October, 1863.

Slickensides in the Granite near Dublin.—In a paper read during the summer before the Geological Society of Dublin, it was pointed out by the Rev. Maxwell Close, that our notions of the phenomena productive of these striations are exceedingly unsatisfactory. In Dublin granite, a great number of surfaces (which, in the author's opinion, are always joint surfaces), and which present more or less marked striations, may be observed. Some of them are indicated in the maps of the Geological Survey, and all of them are like the peculiar groovings known as galena *slickensides*. Indeed, the resemblance to the latter is so great, that Mr. Close concludes that a cast of one could not be distinguished from a cast of the other. After enumerating the existing theories, none of which sufficiently account for the phenomena referred to, the author advances a new hypothesis—that of crystallization. Several facts are brought forward in support of this view, and the paper concludes with the following remarks: "The striated coatings are later than the joints which carry them: they were formed after the consolidation of the granite, but also they were formed before certain other joints which cut through them, or before the granite had attained its final structural condition; that is to say, after the cooling of the granite had begun, and before it was completed. Perhaps we may have in thermo-electric currents the polarizing force we seek. We know that light is able to influence crystallization, as also the action of a powerful magnet. It seems easier to explain by thermo-electric agency than by the more widely acting currents of terrestrial magnetism, the variation in direction of the striations which we have noticed, and also the fact that near the boundary of the granite (when the cooling of the intruded mass must have been comparatively rapid and irregular), the slickenside phenomena are either *absent or confused*."

The Earth's Crust.—A paper of a peculiarly speculative type was recently read on this subject before the Natural History Society of Montreal. The writer endeavoured to work out the theory supported by Sir H. de la Beche, of the incandescent character of the globe, prior to the development of organic beings. The paper is one of considerable length, and bears evidence of the author's having given the question serious consideration. As prefatory to his argument, the writer (Mr. Macfarlane) states:—"It is, I believe, possible to maintain, with every appearance of reason, that the primitive gneiss formation constitutes the first solidified crust of the originally fused globe, and that the crystalline and subcrystalline rocks of the primitive slate formation are the products of a peculiar transition period, during which aqueous fluids gradually accumulated on the surface, and the latter attained a temperature approaching somewhat to that of the present day."

The Sternum of a Fossil Tortoise from the Gypsum Hills of Sannois is described by M. Valenciennes, in a memoir presented to the French Academy on the 23rd of November last. The peculiarity of the observations is that the latter are made upon an animal which has not been found complete, but which has been reconstructed. "Birds," says the distinguished naturalist who contributed the memoir, "have the sternum composed of *five* pieces; tortoises invariably possess nine sternal portions. This number once determined, led me to believe that this was a case in

which I could reconstruct the animal. It had been crushed, so that there remained only the inferior portion of the carapace, which gave passage to the humerus. The great groove which is seen here is the right humeral groove of the animal. Posteriorly we find the portions the sternum, viz., the episternal, the space covered by fragments of the hyosternal and hyposternal, and finally the xiphosternal." In this manner M. Valenciennes proceeded, step by step, to prove to his audience that the bones before them were those of a huge fresh-water Emys, which, in compliment to its discoverer, M. Hebert, he proposes to term, *Testudo Heberti*.

The Stone Age in the Pyrenees.—Messrs. Garrigon and Filhol have just laid before the French Academy the results of their explorations of the caverns in some of the mountain passes of the Pyrenean chain. They discovered in several caves large quantities of bones, belonging principally to the following animals:—*Cervus elaphus*, a large species of ox, and a much smaller one, a sheep, an antelope, a chamois, *Sus scrofa* and a smaller domesticated species, the horse, the wolf, the dog, the badger, the hare, and two birds whose species were undetermined. Besides these there were found weapons of stone, and some which had been prepared from the bones of animals; twenty millstones formed of leptinite, granite, and syenite, and of various sizes; and numerous fragments of a rude sort of pottery containing fragments of quarts and mica. From these facts these two geologists draw the conclusion beneath:—

"In the Ariège section of the Pyrenees (and doubtless also throughout the entire chain) there has been a pre-historic population, whose habits and state of civilization were like those of the race of the Stone age in Switzerland. This race inhabited large and airy caverns, fed upon the flesh of animals in which the country abounded, and manufactured weapons of the harder portions of the bones and of stone. They probably cultivated wheat like their Swiss brethren, and doubtless the mill-stones found were employed to grind it. They were unacquainted with the metals."—*Comptes Rendus*, vol. lvii. No. 20.

Cause of Earthquake Shocks.—This has been attributed by Mr. Mackie, the well-known editor of *The Geologist*, not to the outpouring of molten matter from the bowels of the earth, but to the cooling down and crystallization of the fluid lava. It is well-known to chemists that during the crystallization of certain compounds, in one stage of the process, a perceptible series of sounds may be distinguished. Manufacturers of crystalline bodies on a large scale are even more familiar with this phenomenon; and we have been informed that in the preparation of some mineral compounds very loud sounds, like those resulting from explosions, are heard as soon as the solid deposit begins to separate from the liquid mass in which it was dissolved.

Composition of the Water of the Dead Sea.—The water of the Lacus Asphaltites of the ancients contains, according to the recent researches of M. Roux, so large a quantity of bromides and bromine compounds, that it is worthy of consideration by all photographic and other chemists who desire to render these substances commercially cheaper and purer than they are at present. In one hundred parts of Dead Sea water there are 9·466 parts of chloride of magnesium; 6·126 of chloride of sodium; 3·152

of chloride of calcium; 1·388 of chloride of potassium; 0·364 of bromide of magnesium; 0·058 of sulphate of lime; 0·004 of chloride of ammonium; 0·032 of carbonate of lime, oxide of iron, and alumina; 0·010 loss; and 79·400 of water. A litre of Dead Sea water taken on the 24th of February, 1862, contained 206 grammes of saline matter. There is no mineral water so highly charged with salts, or which possesses so much bromine.—*Comptes Rendus*, Oct. 5, 1863.

Fossil Fresh-water Sharks.—At a recent meeting of the Belgian Academy of Sciences, M. Dewalque, in treating of the diluvial deposits of the Meuse, brought one or two remarkable facts (?) under the notice of the members. A few years ago, whilst some public works were being carried on, a large shark's tooth was found in the gravel of the Meuse. He himself examined it; it was nine centimetres long, and belonged to the genus *Carcharodon*, bearing a decided resemblance to the teeth of *C. megalodon*, which is so frequently found at Anvers that his colleagues thought that he was deceiving them. Now this tooth had been obtained by its possessor from a person who found it on the works whilst engaged with his pickaxe; this, it must be remembered, occurred at a period anterior to the operations at Anvers. Again, M. Folie, of our School of Mines, sent the author some teeth which were found by his brother in the excavations made in connection with the citadel at Namur. They came from a deposit near the port of Salzinne, on a portion of flat country which is annually inundated, and were taken from a depth of fifty centimetres. One belonged, undoubtedly, to *Carcharodon megalodon;* four were those of *Oxyrrhina trigonodon;* and a sixth, which probably belonged to the latter also, was distinguished from the rest by having its cutting edge slightly re-curved towards the apex. Although the sharks are marine species, still there are some which ascend rivers to considerable distances —the Lamna, for example. These facts may not be readily accepted, but they are worthy of the consideration of geologists.—Vide *L'Institut*, Oct. 28, 1863.

MECHANICAL SCIENCE.

The Steam Engine.—Considerable attention has been drawn lately to the question of the speed attainable in land and marine engines. Hitherto a velocity of piston averaging 250 feet per minute has been almost universally adopted, and there appear to be sound objections to any great increase of this speed in the old form of beam engine, in consequence of the enormous weight of the reciprocating parts. In America, however, much higher speeds appear to have been attained even with beam engines, in cases where they had a stroke of 12 feet in length. Thus, the engines of the Pacific mail steamship *Golden City* are reported to work at a velocity of 420 feet per minute; those of the *Buffalo City* at 468 feet; the *C. Vanderbilt* at 540 feet; and the *Stockton* at 640 feet. The objections to a high speed of piston which are urged with force in the case of engines with heavy reciprocating parts, the motion of which has to be reversed in direction twice in every stroke, do not apply to the class of vertical and

horizontal direct-acting engines now so largely introduced. Hence there is no reason why the old-fashioned speed of 250 feet should be adhered to, and in the case of locomotives where necessity has compelled the change, speeds of 500 to 1,000 feet per minute are attained without difficulty. The little horizontal engine of Mr. Allen, in the Exhibition, worked regularly and with great steadiness at a piston speed of 600 feet per minute, doing twice the amount of work which it could have accomplished at the speed usual in this country. There is now no doubt that the direction of improvement which will be taken will be the adoption of a high speed and higher pressure than hitherto, with an enormous saving in the weight of the engines necessary for any given amount of work.

Steel Vessels.—Two ocean vessels of large size have been launched at Liverpool, built entirely of steel, which had indeed been used before, but tentatively, and in smaller ships. In the case of the *Formby*, of 1,276 tons burden, 300 tons of dead weight were saved out of 800 tons (which would have been necessary had she been built of iron), in consequence of the greater tenacity of the new material.

Glass Bearings.—Glass bushes or steps are being used for bearings for shafts, by Mr. Burton, the glass being protected at the ends by metal flanges attached to the pedestal, with papier-maché or india-rubber interposed.

Forging by Pressure.—Attempts are being made by Mr. Haswell, the Manager of the Austrian State Railways, and by Messrs. Shanks, E. B. Wilson, and Bessemer, to substitute hydraulic pressure for the blows of hammers, in forging masses of wrought iron and steel. The first-named has a press at work capable of exerting a pressure of 600 tons, by means of which he has been enabled to forge a piston and rod in one piece at a single stroke.

Clifton Suspension Bridge.—Our readers will be aware that the old Hungerford Suspension Bridge, having been taken down and replaced by Mr. Hawkshaw's fine lattice railway bridge, is being re-erected at Clifton, near Bristol. For this purpose an ingenious temporary scaffolding has been contrived, on which the links of the chain are to be put together. In the position to be occupied by one of the chains, six wires have been stretched across from pier to pier, and above these two other wires from which a light cradle is suspended. In this cradle the men were enabled to attach to the lower wires a platform of boards joined to the upper wires by hoop iron forming a railing. Fourteen feet above the platform another wire is stretched across, on which runs a traverser, furnished with blocks, by which the links of the chain are carried out to the men at work on the platform. In this way the great natural difficulties of the situation will be successfully overcome. The bridge will be 702 feet span, and 280 feet above low water.

Bhore Ghaut Incline.—The incline up the Bhore Ghaut range, recently completed, is one of the most remarkable achievements of Indian railway engineering. It is nearly 16 miles long, with a total rise of 1,831 feet, the steepest gradients being 1 in 37 and 1 in 40. It includes 25 tunnels and 8 viaducts, with 1,250,000 cubic yards of cutting, chiefly through rock, and 2,000,000 cubic yards of embankment. It has occupied seven years in construction.

Resistance of Armour Plates.—From a paper read by Mr. Fairbairn at the Institute of Naval Architects, in March, but only recently printed, we extract the following table to show the close accordance of a formula for the penetration of plates, by steel flat-ended shot, deduced more than two years ago, from experiments with a rifle, and the more recent experiments of Mr. Whitworth; the table is also interesting as an exact and reliable record of the best artillery practice against plates by the English Government:—

Description of Gun.	Weight of Shot in pounds.	Charge of powder in pounds.	Velocity of shot in feet per sec.	Semi-diameter of shot in inches.	Maximum thickness of penetration by formula in inches.	Thickness actually penetrated in inches.
Wall piece Rifle .	0·34	...	1141	0·435	0·81	0·81
Whitworth 12 Pr.	12·06	1·875	1202	1·5	2·72	2·50
„ 12 Pr.	12·16	1·750	1157	1·5	2·63	2·00*b*
„ 70 Pr.	68·50	12·00	1276	2·75	5·09	4·00*c*
„ 120 Pr.	129·00	23·00	1278	3·5	6·20	4·50*d*
„ 120 Pr.	130·00	25·00	1268	3·5	6·17	4·50*e*
„ 120 Pr.	130·00	25·00	...	3·5	6·17	5·50

b. The shell penetrated 12 inches of wood backing and buried itself in a sandbank.

c. Penetrated 13 inches of wood backing and cracked a 2-inch plate in the rear.

d. Penetrated 20 inches of wood backing and fractured iron skin.

e. Shell burst whilst penetrating wood backing.

The same formula with a variation of a single constant applies equally well to the penetration of plates by cast-iron shot.

Corrosion of Armour Plates.—The *Royal Oak* having been docked at Keyham, has revealed a new and insidious danger besetting our iron-cased fleet. The lowest tier of her armour plates is all more or less honeycombed, and partially destroyed by galvanic action arising from contact with the copper sheathing below. The holes vary in depth from $\frac{1}{4}$ to $\frac{5}{8}$ inch. She has not been more than five months in the water. Plates of vitreous sheathing are to be applied to prevent further injury.

Centrifugal Pumps.—Careful experiments on one of Appold's centrifugal pumps have been made by Mr. Anderson, at Wexford. These were on a scale and under circumstances which render the results more reliable than in most previous experiments. With from 44 to 60 indicated horse-power, 1,600 to 2,200 cubic feet of water were lifted from 6 to 10 feet high per minute. Averaging the results and deducting one-sixth of the power expended as engine friction, the efficiency of the pumps appears to be 67 per cent.

The Armstrong Gun.—A new gun of Sir William Armstrong's, weighing 22 tons, and 13·3 inches calibre, has been successfully tested at Shoeburyness. The thickness of the walls at the breech is 20 inches, the outside diameter being 55 inches. The total length is 15 feet. The rifling is on

the "shunt" principle, this gun having 10 grooves, turning once in 65 calibres. It carries a conical cast-iron shot weighing 510 lb., or a shell of 600 lb. with a bursting charge of 40 lb. of powder. The charge for the gun was 70 lb. with the shot, and 60 lb. with the shell. With shot the range attained was 1,160 yards with 2° elevation; 2,300 yards with 5°; 4,100 yards with 10°. The mean initial velocity of the shot was 1,260 feet per second. The lateral deviation varied from 0 to 4 yards only. A shot from this gun perforated a target representing a section of the *Warrior's* side, making a clean hole 2 feet long by 20 inches broad.

The Lynall Thomas Gun.—Experiments of a less satisfactory character have been made with a Lynall Thomas 300-pounder rifled gun, the rifling being formed of ridges instead of grooves. Charge of powder 40 lb.; initial velocity of projectiles, 1,075 to 1,217 feet. Range at 5°, 1,883 to 2,161 yards; at 10° elevation, 3,600 to 4,000 yards. The inequality of velocity and range is the most objectionable feature developed by the trials.

Mr. Reed's Target.—Mr. Reed has constructed a target with a facing of 6-inch armour plates, and a backing of 10 inches of teak and two thicknesses of $\frac{3}{4}$-inch plates. As might be expected, it has resisted all the ordinary projectiles and even the steel shell fired from Mr. Whitworth's 150 pounder, with a charge of 23 lb. of powder. These last penetrated the armour plate, but did no injury to the backing. It remains to be seen how far it can resist the blows of the 300-pounder and 600-pounder projectiles with charges of 40 lb. and 60 lb. of powder.

MEDICAL SCIENCE.

The Structure of Cartilage.—Our medical readers are of course familiar with the circumstance that the structure of cartilage is a subject which, since the appearance of Schwann's celebrated work enunciating the "cell theory," has been of much interest to histologists. It is customary in most works on human microscopic anatomy to lay it down as certain and established that cartilage is composed of a clear homogeneous basis, through which are scattered myriads of cells containing nuclei, and that the cartilage grows by the development of new cells. Professor Lionel Beale, of King's College, who may fairly be regarded as one of the first, if not the first, microscopic anatomist in Great Britain, has recently advanced some original views as to the structure and growth of cartilage. We presume they are promulgated with the object of supporting his theory of the development of all tissues from *germinal matter* (endoplasts of Professor Huxley). Be that as it may, his paper is a most valuable one, and may be found in "The Transactions of the Microscopical Society," vol. xi. The beautiful plates accompanying the memoir convey a clearer description of the structure of the tissue in question than any verbal explanation, and must be referred to by all interested in this subject. The conclusions at which the author has arrived are the following:—(1) That the so-called intercellular substance of cartilage and other tissues is never formed independently of *cells*, or, more correctly, masses of living or germinal matter;

(2) that the intercellular substance does not possess formative power, and that physical and chemical changes alone take place in it; (3) that in all cases the masses of germinal matter are continuous with the so-called intercellular substance, and that the latter was once in the state of germinal matter; (4) that in the development and growth of these tissues, the pabulum becomes germinal matter, the germinal matter becomes the formed material (intercellular substance), which accumulates and gradually undergoes condensation. *En passant*, we may observe that, in regard to conclusion 2, the opinions of Dr. Beale and Professor Huxley are diametrically opposed to each other; the former placing the formative power in the endoplasts (nuclei), whilst the latter, in common with Wolff, places it in the intercellular substance, or *periplast*, as he has termed it.

Structure of the Kidney.—Professor Henle has discovered that our present notions of the anatomy of this organ are in part erroneous. The tubules of the kidney, even of man, branch and subdivide in quite as arborescent a manner as they do in the horse. The conical form of the medullary substance is not due to any increase by division of the open tubules, but rather to an internal diminution of the intervening smaller tubules. In the cortical substance of the human kidney, there are two forms of tubules; one whose epithelium is clearly cellular, and the other whose epithelium is rather of the granular type. The author concludes that the open tubules separate the essential elements of the urine, the less important being formed in the closed or looped ones. This view he supports by the fact that the uric acid of children is found in the first, whilst fatty and chalky deposits occur in the second.—*Zeitschrift für rationelle Medicin*, vol. xix.

Accidents resulting from Swallowing Leeches.—It appears from an article in the *Archives Générales de Médecine*, that the soldiers in Algeria are particularly liable to accidents of this description. At the time when the leeches are swallowed, they are so small as readily to escape detection; they are filiform, and rather resemble a blade of grass than anything else. They usually become attached to the isthmus faucium, or to the pharynx, and are sometimes found in the nostrils. When once they have become fixed, they generally remain for a considerable period, and undergo their development rapidly. Dr. Baizeau records a case in which they remained for more than six months within the pharynx. They very seldom come away of their own accord, and must usually be extracted forcibly. If they are too deeply seated to be caught by a forceps, then the patient must gargle his throat with a mixture of vinegar, water, and common salt, and must continue the process for several days. But even this sometimes proves unavailing. The symptoms are those of irritation in the part, together with occasional hæmorrhage. The latter is often mistaken for a symptom of disease of the lungs, stomach, &c. The only preventive appears to be a caution to the soldiers not to drink water from streams, &c., when they are on the march. It is a remarkable circumstance that a leech can live for so long a period under conditions so opposite to those it previously enjoyed, and bears out in some measure the views of those who class the Hirundinei with the Trematoda and Planaria.

Cause of "Angina pectoris."—Following up Claude Bernard's views, Dr. Cahen, in a memoir recently published, supposes that this painful

affection is due to a peculiar condition of the smaller blood-vessels of the chest. He says that there is, *firstly*, a sort of neuralgia of a rachidian nerve (brachial plexus, or intercostal nerve); *secondly*, an extension of this neuralgia to the corresponding portion of the great sympathetic; and, *thirdly*, congestion of those organs whose vessels receive branches from this portion of the sympathetic system.—*Archives Générales*, for November, 1863.

Why Fibrin coagulates.—Schmidt's researches show that the coagulable material of fibrin is contained chiefly in the cells. In fact, neither lymph nor chyle possesses this property till it has mingled with the cells in the lymphatic and mesenteric glands. The various forms of coagulated fibrin are not due to varieties of the fibrin itself, but rather to the nature of the cells which develop it. The operation of the active principle, whatever it may be, is not analogous to that of a ferment, for the principle itself is used up in the process. The presence of carbonic acid always retards the coagulation of fibrin, but this influence is very slightly exerted in the case of fresh blood. The difference of time required for the coagulation of venous and arterial blood may be attributed to the relative quantities of carbonic acid which they contain. Neither oxygen nor atmospheric air affects the coagulation of blood, at least directly; but when oxygen is employed, it occasionally displaces the carbonic acid, and thus brings about coagulation more rapidly.—*American Journal of the Medical Sciences*, October, 1863.

Proto-iodide of Iron and Manna.—M. Foucher recommends the employment of pills containing these substances in combination; he uses purified manna in tears, proto-iodide of iron, liquorice in powder, and mallow. When these are united, a mass is produced in which the protoiodide is completely preserved from alteration by the action of the manna, and which is easily softened by the mere heat of the hand. Hence this drug has two advantages, the preservation of the iron, and the extreme solubility of the mass in the digestive fluids. Moreover, the manna being laxative, prevents the constipation which might otherwise ensue from the administration of iron in other forms.—*L'Union Médicale.*

Organic nitrogenized Principles of the Body.—Very little dependence, in a physiological inquiry, can be placed upon the chemical analysis of the animal fluids. There has not been heretofore a sufficient amount of attention given to the study of the complex juices of the human body. We are glad, therefore, to perceive that this subject has been taken in hand by Professor Flint of New York, who has made an extensive series of analyses of human blood and other fluids. His conclusions are somewhat different from those of previous investigators, but his method of analysis is so simple that we conceive the liability to error was not so great as might otherwise have been. In a study such as that he has undertaken, the author remarks that we must recognize the following important facts:—1st. Organised nitrogenous substances are the only elements of the body in which reside the properties of regeneration and destruction, during life. 2nd. They are of indefinite chemical composition, and *no physiological importance* is to be attached to *ultimate* analyses. They are unstable; in a state of continual change

during life, and soon alter after death, or after being removed from the body. 3rd. They assume the consistence of the tissue or fluid in which they exist. They are solid in the solids, like bone; semi-solid in the semi-solids, like muscle; fluid in the fluids, like the blood. They are not dissolved in water; but water is an ingredient, and its quantity determines their consistence. 4th. In the body they never exist alone, but always combined with inorganic substances, which accompany them in the changes they undergo in the processes of nutrition and destructive assimilation. 5th. As all the *proximate* analyses of the organised fluids, particularly of the blood, have been made with the idea that the organic ingredients were solids in solution in water, their quantitative analyses give, not the proportion of fibrine or albumen, but of dried fibrine and albumen, the original substance having been subjected to a process which drives off its most important constituent, and which alters its properties. Such analyses as representing real quantities are erroneous. We cannot quite coincide with the concluding remarks of Professor Smith, but place them before our readers, as, at all events, suggestive.—*American Journal of the Medical Sciences*, XCII., 1863.

Action of Alcohol in Acute Diseases.—Much as the good folk who delight in Maine liquor law speculations may be surprised at it, it is nevertheless quite true that alcohol is a most valuable remedy in certain diseases of an acute form, and especially in low pneumonia. Dr. Beale has recently published a little pamphlet on this question, and does not hesitate to advocate the employment of alcohol in such cases as those referred to. He explains the difference in results produced by alcohol in the healthy and morbid systems, by the supposition that it is capable only of affecting the production of cells which have been hastily formed and whose walls are, therefore, not sufficiently protected from its influence. Thus alcohol, when administered in cases where cells are being rapidly generated, checks the development of their structures, whilst when administered in health it is incapable of acting on the normal cells by reason of the dense character of their coats. After carefully watching more than one hundred cases of acute disease which had been treated with large quantities of stimulants, the author concludes:—(1.) That intoxication is not produced. (2.) That delirium, if it have occurred, ceases or is prevented from occurring at all in the course of the case. (3.) That headache is not occasioned. (4.) That the action of the skin, kidneys, and bowels goes on freely. (5.) That the tongue remains moist, or, if dry and brown, often becomes moist. (6.) That the pulse falls in frequency and increases in power. (7.) That respiration is not impeded, but that where even one entire lung hepatised, the distress of breathing is not increased. (8.) The respiratory changes go on as well as if no alcohol had been given. In what appeared hopeless cases, as much brandy as the patient could be made to swallow (an ounce and a half to two ounces in an hour) has been given for several hours in succession, and then as much as *thirty* ounces a day for several days, not only without producing the slightest intoxication, vomiting, or headache, but the treatment has been followed by recovery.—See "On the Deficiency of Vital Power in Disease," &c. Lionel S. Beale, M.B., F.R.S. London: Richards.

The Preparation of Flesh as Food.—It is now very generally believed that the present method of killing cattle, and of preparing their bodies for food, is one which requires alteration. For example, under our present system, when sheep, oxen, &c., are killed, a very large quantity of valuable and nutritious material is wasted by the escape of blood. Hence it becomes necessary to inquire how a new process can be substituted, by which the circulating fluid may be utilised. With this object in view, Dr Mapother communicated a paper to the Royal Dublin Society, in which he thinks he has divided the Gordian knot. He certainly has not untied it. His only proposal is that the animal be killed in such a manner as to prevent the loss of blood, and he trustfully supposes that, having informed the public that flesh prepared in this fashion is wholesome, they will at once proceed to adopt his suggestions, regardless of long-existing prejudices. It is not many years since a distinguished experimenter on *other* people's stomachs proposed that the starving Irish should be fed upon curry-powder and water mingled in proper proportions; we are not, however, acquainted with any record of the results of the trial. Now, it certainly seems to us that this gentleman's proposal made for people who are not at all familiar with flesh meat of any kind, was just, *a priori*, as likely to be adopted as that of Dr. Mapother, which can, of course, only refer—in Ireland at least—to those who stand somewhat higher than the *great unwashed.* We hope that the Doctor will, on a future occasion, devise some method of employing abstracted blood as food, for we certainly do not approve of his present proposition. We presume he is able to support physiological assertions by logical proof. But we cannot see how the sun-dried strips of flesh which the American Indians use as food "*confer* on them a degree of health and muscular vigour, scarcely ever attained by any European race." In our innocence of the abstruse physiological reasoning which no doubt supports Dr. Mapother's assertion, we prefer to suppose that the rare health and vigour to which he refers *may* be due to the essentially *natural* mode of life of these hardy tribes.

Characters, Action, and Uses of the Calabar Bean is the subject for which the gold medal was awarded to Dr. T. R. Fraser on his graduating M.D. in the University of Edinburgh. His thesis has now appeared in pamphlet form, and deserves the consideration and attention of members of his profession. He treats in an exhaustive manner of the history of this peculiar drug, and gives also the results of an immense number of experiments made upon the lower animals for the purpose of investigating its action. The bean was first noticed, scientifically, about the year 1840, by Dr. Daniell, and was alluded to in a paper which he read before the Ethnological Society in 1846. The bean, as its name implies, is brought from the west coast of Africa, where it is employed by the natives in the trial by ordeal. It is used by them as a test to distinguish between the innocent and guilty. Dr. Fraser writes: "The priest, as administrator, offers up a prayer that the gods may continue to the bean its power to kill the *guilty.* The accused is then permitted to receive the ordeal bean, either in the form of infusion, or of the dry kernel. Sometimes a portion of one bean only is taken, at others as many as twenty-five, according to the discretion of the priest, or until innocence is held to be declared by the pro-

duction of vomiting, or the guilt of the accused proved by his death. The medicine men are by no means scrupulous in the accomplishment of their object, and if, from any cause, they desire the death of their victim, a club is employed to compensate for the slowness or failure of the action of the poison." The bean belongs to the order Leguminosæ, and its technical name is *Physostigma venenosum*. The action of the kernel when administered internally is to be referred entirely to the spinal cord. The contraction of the pupils, which is one of the results, may be produced in three ways: positively by cerebral irritation; negatively by spinal depression; and complexly by a combination of the two. The symptoms prove that the first never occurs, therefore the second must be the only cause. In fact, the balance between the dilators and contractors of the iris being destroyed by the depression of the nervous centres affecting the first, the contractors operate, and so close the iris. Death takes place either by asphyxia or by syncope, but possibly the heart's action may be interfered with primarily owing to the special action of this medicine on the cardiac muscle. Dr. Fraser, who experimented very extensively upon himself, describes minutely the strange sensation felt in the epigastrium after a dose of six grains of the finely-powdered kernel had been taken; and has also recorded the alternations in point of frequency of the pulse.

Treatment of Asthma by Static Electricity.—In the *Comptes Rendus* for November 23, we find a note from M. Poggioli, stating that he has produced some extraordinary cures of this unpleasant ailment by means of electricity. He says that four cases of asthma, which were incurable by ordinary remedies, were treated by electricity with an amount of success as surprising to the physician as the patient. He was quite certain that the cases were those of genuine asthma. He would not approve of employing electricity in cases of symptomatic asthma combined with either disease of the heart or pulmonary emphysema.

Bacteria in the Blood of Persons labouring under Typhoid Fever.—M. Velpeau recently presented a note from the Italian Professor, Tigri, recording the presence of these beings in the blood of a man who died of typhoid fever. This statement is of exceeding interest, as it tends to confirm an opinion for some time prevalent among scientific physicians, that zymotic diseases originate in the development of certain vegetable spores.—*Comptes Rendus*, No. 20.

Palmidactylism Reappearing during several Generations.—M. Berigny described some interesting cases of this phenomenon at a recent meeting of the French Academy. He said, starting with the first generation, the mother had the third and fourth toes of the *right* foot webbed throughout their entire length, her husband's hands and feet being normal. The second generation, which consisted of seven children—three boys and four girls—did not exhibit this peculiarity. In the third generation, one of the daughters gave birth to a girl (the eldest), whose middle and ring fingers of the right hand were webbed like her grandmother's toes. Another sister also gave birth to a boy and girl, both of whom had the middle and ring fingers of the right hand webbed. Of three boys, brothers to the preceding, one had five children, of which the eldest, a boy, came into the world with the same anomalous condition of the extremities. In

the fourth generation, one of the great-grandchildren was father to twins one of which exhibited the webbed condition of the right foot which was presented by her great-grandmother, and also to a boy, whose right hand was webbed like that of his father. There are three strange facts brought forward here. (1) The entire absence of the peculiarity in the first generation; (2) the infirmity was confined to the eldest children; and (3) it only affected the right side of the body.

METALLURGY AND MINING.

Asphalt Oil a Substitute for Coal.—This idea has been suggested in an important memoir reproduced in the *Trinidad Colonist* by a Mr. Stollmeyer. There is in one portion of the island of Trinidad, and not above a mile from the shore, a basin of asphalt, which extends over an area of nearly a hundred acres. Besides this, there are numerous springs of a similar nature in the neighbourhood. Now it has been calculated that the lake is capable of supplying several hundred millions of gallons of oil, there being about seventy gallons of pure oil obtained from every ton of asphalt. As about forty-five gallons of the oil are equivalent to a ton of coals, it follows that the time required in loading a ship with oil would not be at all as great as in the case of coals, and moreover the necessary quantity of oil for consumption would not occupy nearly so large a space. It is, however, questionable whether the method he suggests the employment of, in order to obtain combustion, is a satisfactory one.

Waste of Coal is the subject of a very interesting article from Professor Ansted's pen, in the November number of the *Mining and Smelting Magazine*. He looks upon the eventual exhaustion of our coal-beds as likely to arise from other causes than those alluded to by Sir William Armstrong in his late address. There is the justifiable and the unjustifiable expenditure of this important mineral. It is to the latter especially that Professor Ansted draws his readers' attention. Waste of coal takes place in three different ways. First: Waste of whole beds of coal. It is by no means unusual in certain mining districts to sacrifice an overlying seam of tolerable coal if that beneath it is of more value, and pays better; the result of which is that as soon as the lower seam has been exhausted, the upper one becomes valueless, because, being unsupported, it cannot be worked. Even when there is a solid roof, the coal becomes cracked through, and admitting both water and gas, is no longer workable in a pecuniary point of view. Second: Waste of seams a foot thick above, and others of the same depth below, which are employed to support the roof and floor, which might have been done by artificial means. Again, large pillars of coal are often allowed to be crushed to powder in order to avoid the expense of the heavy timbering and stone walls which would be necessary to prevent it. "In some cases, nearly or quite one half of a valuable seam is thus sacrificed." Third: Waste, as small-coal or dust, which is regarded as valueless, and is either left within the pit or at its mouth. This might be easily utilized, and is employed in other countries; and the waste of this kind occurring in "tender" coal is hardly conceivable. It is sometimes

burnt merely in order to be got rid of. It certainly seems as if, according to Professor Ansted's suggestion, some legislation were necessary to prevent this wanton destruction of an element so essential to the well-being of our manufactures. We trust Government will soon take the matter in hand.

Explosions of Steam Boilers.—That the influence of the association for the prevention of these fearful accidents is a beneficial one is shown by Mr. Fletcher's report to a late meeting of the society. During the previous month there had been no less than three hundred and thirteen engines and four hundred and seventy-one boilers examined, of which five were fractured, fourteen were in a state of corrosion, and seven with safety-valves out of order. There were nine explosions during the month, by which five men were killed. It is satisfactory to know that none of these boilers were under the inspection of the society, and that in one of them the injuries were so well marked that they could not have escaped the detection of a skilled inspector.

Utilization of the Cinders from Puddling and Reheating Furnaces.—A process has recently been proposed for the extraction of iron and steel from the refuse of the above-named furnaces. The cinders — which are usually rejected from the circumstance that they contain large quantities of sulphur, silica, &c., inseparable from the iron—are extremely valuable, and contain from twenty-five to fifty per cent. of the latter metal. The following is the method adopted :—A quantity of unslaked lime is mixed with fine-ground cinder, and then wetted and exposed to the air, when during the process of slacking, the lime and silica unite. The mass is now removed to a puddling furnace and heated. The result is, that about fifty per cent. of wrought iron is obtained. It is, however, tainted by sulphur, to remove which it becomes necessary to dissolve chlorine salts in the water used in slacking the lime. The pecuniary expenditure is not considerable, and a great saving of material is achieved.—*United States Mining Register.*

Proposed New Form of Siemen's Furnaces.—It is proposed to apply Siemen's furnace in a novel way. M. Desmarest thinks it of advantage, in certain processes in which there are two consecutive stages in the operation requiring different temperatures, to employ double furnaces, so that the two connected processes may be carried on in the same apparatus by reversing the currents of heat. For the details of the apparatus, we must refer the reader to the *Mining and Smelting Magazine* for October.

Ventilation of Collieries.—A successful instrument for this purpose has been recently tested at one of the mines near Tenby. It consists of a large circular fan of about eighteen feet in diameter by four feet, breast, and is arranged in such a manner on the surface, over the upcast shaft, that it absorbs without leakage all the gas and foul air of the colliery. From this it is thought that it may supersede the furnace at the bottom of the shaft, and which is frequently dangerously close to the large subterranean reservoirs. The fan is driven by an engine at the rate of about one hundred and twenty revolutions per minute.—*The Artizan* for November.

Extraction of Thallium from the Flue Dust of Pyrites Burners.—The manufacture of this metal on a large scale is minutely described by Mr. Crookes. The process is as follows :—The dust is first placed in wooden

tubs, with an equal weight of boiling water, and well stirred, a good deal of nitrous acid being given off; it is then left standing for twenty-four hours. The residue is then washed, etc., and treated afresh with boiling water. The first decanted liquid is, when cool, precipitated by hydrochloric acid in excess, and the subsiding precipitate is impure chloride of thallium. This is washed and dried, and is obtained in the proportion of 68 pounds to every three tons of dust. In the next step of the process, the impure chloride is converted into a sulphate, and this is then, by hydrochloric acid, thrown down as *pure* chloride. This is now reconverted into the sulphate, which is obtained as a white crystalline mass, that evolves much heat on being placed in water. Even now it is not sufficiently pure, and must be re-crystallized, a little hydrosulphuric acid having been first added, in order to throw down any arsenic, mercury, &c., which may be present. The best method of obtaining the metallic substance is by precipitation with zinc plates. "Plates of pure zinc (which must leave no residue whatever when dissolved in sulphuric acid) are arranged vertically round the sides of a deep porcelain dish, holding a gallon. About seven pounds of crystallized sulphate of thallium are then placed in the dish, and water poured over to cover the salt. Heat is applied, and in the course of a few hours the whole of the thallium will be reduced to the state of a metallic sponge, which readily separates from the plates of zinc on the slightest agitation. The liquid is poured off, the zinc removed, and the spongy thallium washed two or three times. It is then strongly compressed between the fingers, and preserved under water until it is ready for fusion." The latter is effected by placing the metal in lumps in an iron crucible, fixed over a gas-burner, and which is so arranged that a constant stream of coal-gas blows into its upper portion. The molten metal is then stirred up with an iron rod, and may be obtained in either the granulated or ingot form.—See the *Chemical News*, October 3rd.

Forms of Pyrites used on the Tyne in the Manufacture of Sulphuric Acid.—Such is substantially the title of a paper read by Mr. J. Pattinson, before the British Association, at its Newcastle meeting. Up to 1856, the only supplies of this mineral were derived from local sources, from Cornwall and from Ireland; but since that period supplies have been obtained from Norway, Sweden, Tuscany, Spain, Portugal, Belgium, and Westphalia. The quantity of pyrites consumed in this single locality is enormous, amounting as it does to seventy thousand tons per annum, or, in a monetary aspect, to an expenditure of £105,000. The subjoined table indicates the respective value in sulphur of each form :—

Form of Pyrites.	*Per-centage of Sulphur.*
1. From Huelva in Spain, and Algarve in Portugal	49·30
2. From the Rocheux mine, Theux, near Spa	45·01
3. Westphalian	45·60
4. Norwegian, from the Island of Hitteren	46·50
5. Irish, from the Wicklow mines	44·20
6. Coal brasses, from the Walker colliery	33·10

Minerals and Salts of Coal Pits.—According to the researches of Messrs. Clapham and Daglish, the minerals found in coalpits are not given in

analyses, generally. They found the following substances in the localities referred to, but they admit that some of them were found in isolated masses:—Carbonate of iron, carbonate of lime, sulphide of lead, sulphide of copper, sulphide of iron, and sulphide of nickel embedded in carbonate of lime; also arsenic, sulphate of baryta, and hatchetine.

Chemical Composition of Cast Iron.—Herr Rammelsberg has communicated his views on this question to the Academy of Sciences in Berlin. After alluding to the observations of Karsten, he goes on to say: "I have recently analysed the iron of Müsen, and found it to contain 5·8 per cent. of combined carbon; and also graphite, which presented itself in lumps. Having dissolved some in hydrochloric acid, I found a marked residue, which, after being heated frequently in fresh acid, and washed, was treated with potash in a platinum dish. There was a rapid evolution of hydrogen, whilst the silicon was converted into silica. This disengagement of hydrogen was accompanied by the characteristic odour of the oily carbide compounds. The alkaline liquid having been separated by filtration, the filtrates seemed disturbed, as I suppose from the presence of titanic acid. The residuary graphite was washed in ether and alcohol, and afterwards carefully dried, and presented the aspect of pure graphite." . . . . "It is quite correct to say that specular iron is a combination of iron and carbon. But Karsten's idea, that it was the form which contained the largest proportion of carbon, is without foundation. Specular iron may contain very variable quantities of carbon, without having its external characters altered. It might be presupposed that other electro-negative bodies might take the place of carbon in specular iron, and especially silicium, but analysis goes to prove the contrary. Those which contain most carbon, contain also most silicium." Herr Rammelsberg endeavoured to determine the chemical formula of the crystals of grey cast iron; but evidently, in such a case, much must be hypothetical.—See *L'Institut*, November 4th, 1863.

MICROSCOPY.

[In accordance with their true and recognised relations, it has been deemed expedient to distribute those portions of the Quarterly Retrospect embraced by the above term, among the three sections: Botany, Zoology, and Medical Science. For the convenience of readers, however, the titles of those papers which relate to the so-called Microscopic Science are here subjoined:—]

Zoological Section—

Reproductive Phenomena of Amœbæ.
Two Species of Entomostraca new to Britain.
Nervous System of Mollusks.
Development of Bothriocephalus latus.
Influence of Infusoria over the Process of Germination.

Botanical Section—

Leaf-cells of Hymenophyllum and Trichomanes.
Anatomy of the Cytineæ.

Vascular System in Plants.
Observations on Raphides.
Literature of Raphides.

Medical Sciences—

Bacteria in the Blood of Persons labouring under Typhoid Fever.
The Structure of Cartilage.
Structure of the Kidney.

A new compressiorium of the reversible kind has been devised by Mr. Slack and Messrs Smith and Beck, and manufactured by the latter. It is, in principle, simply an aquatic box, which by means of a screw can have the two surfaces of glass approximated without their undergoing any rotation. One of its advantages, and certainly no mean one, is that the glasses can be removed, so that the observer can employ either thick pieces for compressing large objects under a low power, or conversely thin plates for higher objectives. It is a decided improvement on the instrument suggested by Professor De Quatrefages.

MINERALOGY.

Presence of Titanium in Pig Iron.—The small red cubical crystals which are found in the hearths of old blast-furnaces were supposed by Wollaston to be titanium, but were afterwards shown by Wöhler to be a compound of nitride and cyanide of titanium. The subject has been taken up for investigation by Mr. Edward Riley, F.C.S., who finds that titanium is abundant in iron, and that as it is, according to his researches, also found in clay, its presence in the former is most probably due to the employment of the clay-iron ore. Hitherto titanium held a very low place in the published analyses of iron, and it was supposed that its most abundant sources were rutile, anatasse, iserine, ilmenite, and some other minerals. In two analyses of Norwegian ore, Mr. Riley found 36·33 and 40·80 per cent. of titanic acid present. In Belfast iron ore dried at 230° Fahr. he found as much as three per cent of this mineral. He believes that titanium exercises some beneficial influence in the manufacture of iron and steel, and that in this respect it is analogous to manganese, the exact nature of whose action is unknown. He supposes that titanium, from its affinity for carbon and nitrogen, acts as a carrier of cyanogen to the steel.

Glucinum and its Compounds.—Perhaps the most exhaustive memoir that has appeared for a considerable period of time, is that by Professor Joy, in the *American Journal of Science and Art* (xxxvi.). The history of the discovery of this mineral is first given, and then follows a list of all the minerals in which it has been found, together with the names of the chemists who recorded its discovery, and those of the journals in which these observations were published. Glucinum is found in the following minerals:—Alexandrite, alvite, aqua-marine, beryl, chrysoberyl, cymophane, Davidsonite, emerald, enclasse, gadolinite, goshenite, helvine, leucophane, melinophane, phenacite, smaragd, and tyrite. There are twelve different methods by which glucina may be separated. (1) By

passing chlorine gas over a calcined mixture of beryl, oil, and lampblack. (2) By treating beryl with concentrated hydrofluoric acid and sulphuric acid. (3) By digesting seven parts of beryl and thirteen parts of fluor-spar in eighteen parts of concentrated sulphuric acid. (4) By fusing beryl with three parts of fluoride of potassium, and digesting in sulphuric acid. (5) By fusing beryl with fluoride of ammonia and digesting in sulphuric acid. (6) By digesting fifty parts of beryl in thirty parts of sulphuric acid, and fusing with one hundred parts of ferrocyanide of potassium, and seventy parts of chloride of sodium. (7) By fusing beryl with fluor-spar. (8) By fusing beryl with binoxide of manganese. (9) By fusing beryl with three parts of carbonate of potassa and two of carbonate of soda. (10) By fusing beryl with half its weight of caustic lime. (11) By fusing beryl with litharge. (12) By fusing beryl with two parts of carbonate of potash.

Nickel and Cobalt in Ironstone.—As an instance of the very general distribution of rare minerals, Mr. Pattinson's remarks on this matter are interesting. In a series of analyses of the Cleveland ironstone and ores, he found that both nickel and cobalt are present in the following proportions:—In a pound of ironstone there are 0·72 grains of nickel, and 0·42 of a grain of cobalt. Pig-iron contains 0·027 of nickel, and 0·004 of cobalt, per cent. In malleable iron there are 0·022 of nickel and 0·003 of cobalt. Although the admixture of nickel with iron is said to improve the quality of the latter, the proportions here present are evidently too small to influence the nature of the metal.

Characters of Schreibersite. — In a memoir read before the French Academy, on the 16th of November, M. Faye described the character of this mineral, and showed how he produced an artificial compound having most of its properties. Schreibersite is a mineral found in meteoric stones, and presents itself in the form of small scales or yellow fragments, with a metallic lustre like magnetic pyrites, with which it is often confounded. It does not present the slightest trace of crystallization. It is attracted powerfully by the magnet, and then acquires a permanent polarity; it is unaffected by hydrochloric acid. According to Professor Smith, of the United States, its atomic formula is $Ni_2 Fe_4 P$. It is to it alone that the phosphorus of meteorites is due. The method adopted for its reproduction artificially by Mr. Faye was as follows:—Fixed quantities of oxide of nickel and sesquioxide of iron were mixed with silica, phosphate of soda, and carbon reduced. The mixture, contained in a charcoal crucible enclosed in an earthen one, was brought to a white heat. In a portion of the resulting mass was found a quantity of yellow particles, with a bright metallic lustre, strongly attracted by the magnet, and quite unaffected by either hot or cold hydrochloric acid; in fact, the resulting substance possessed all the characters of Schreibersite.

PHOTOGRAPHY.

"*The Watt Photographs.*"—For some months past a mysterious story has been afoot that certain pictures—in one case resembling

in every respect ordinary Daguerreotypes, and in another paper photographs, or positive prints—had been discovered in the library of the late Matthew Boulton, at Soho, Birmingham, a room that had not been opened for fifty years ;* consequently leading to the startling conclusion, that the discovery of producing and fixing pictures by photographic agency must date from a much earlier period than is ordinarily assigned to it in the history of photography, and that priority of that discovery is attributable to Englishmen instead of French *savans*. In the month of November, 1862, Mr. Smith, of the Patent Museum, South Kensington, having occasion to visit Birmingham, discovered in the counting-house of Boulton's factory the paper and metal pictures ; and as these were alleged, by persons on the spot, to have been produced by James Watt, he collected the following particulars regarding these interesting and mysterious relics : — The paper pictures, from ample documentary evidence connected with them, prove to be the result of a process discovered by a Mr. Francis Egerton, who was in the employ of Boulton. These are of large size, and on paper bearing the name of "Whatman," proved by the water-mark to be about one hundred years old. The pictures are numerous, and, without exception, copies of paintings, mostly from the works of Angelica Kauffman and Benjamin West, but *reversed*, some of the figures being left-handed ; were apparently produced in monochrome, and afterwards coloured by a person named Barney, of Wolverhampton, who coloured for the Boulton firm before Watt became a partner ; were sold at a very low price, considering their size—viz., about 7s. 6d. per copy, as proved by existing invoices ; and while there is nothing to prove that they have been produced by photographic agency, there is nothing, on the other hand, to militate against such a conclusion, with the exception that an analytical chemist can discover no trace of silver in the sample first assayed ; but then, other salts are subject to the influence of light. But one thing is certain : they could not have been produced by aid of a camera, as no lens of that day could have rendered subjects of their size with such freedom from distortion. These paper pictures were produced in 1780, and each subject is evidently from the same *cliche*. With regard to the pictures on the metal plates, they were found packed between two pieces of Quebec yellow pine ; and by a label attached to one, its subject is stated to be that of Matthew Boulton's house at Soho, before the alterations in 1791 ; and an old man of the name of Townshend, who died some years since at the age of ninety-two, is stated to have declared to Mr. Price, the agent of the Boulton family, that he had actually seen the picture taken, at the same time giving the names of persons who were present on the occasion. Mr. Shadbolt has examined these microscopically, and he states his conviction that the images in each have been formed by means of a lens, probably a quartz spectacle lens, and sensitive chemicals, and that they are, in the strictest sense of the term, photographs of the original object portrayed, and not reproductions from drawings, as in the

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* This part of the statement, we are informed, has been contradicted by one of the Boulton family.

previous instance; and from this gentleman's experience in matters photographic and microscopic, we may regard it as authoritative. Then we have the statement of Mr. Price, that at the time of the removal from the old house a camera was discovered, which was afterwards lent by him to a local schoolmaster who gave his attention to the modern branches of photography, and this person produced some good pictures by its aid, and expressed great satisfaction with the lens of the instrument. This camera, however, is not now forthcoming.

Next we have accounts of a society—"The Lunar Society," that met at Boulton's house "every full-moon night"—that included as members such men as Samuel Galton, of Birmingham; Matthew Boulton, of Soho; James Watt, of Soho; Captain Keir, Mr. Edgeworth, Dr. Withering, Dr. Rooke, Dr. Priestley, Dr. Parr, Dr. Davison, Mr. Day, Sir W. Herschel, Sir Joseph Banks, Dr. Solander, Dr. Aveling, Dr. Small, Benjamin Franklin, Dr. Black, Mr. Roebuck, Dr. Johnson of Lichfield, Mr. Wedgwood; —who gave great attention to these pictures, stayed very late at night, and, according to old Townshend's version, were in the habit of "putting their heads in a bag," an operation not unknown to peripatetic photographers of the present day who give themselves to dry-plate processes, but more probably pointing to the cloth cloak that descended from the ceiling in old-fashioned camera-obscura rooms wherein the lens was fitted above the roof, used for the purpose of excluding extraneous light, and probably used by the society for the purpose of making drawings of the moon or other astronomical diagrams or observations. As the elder Wedgwood was a member of this society, it is quite natural that he should have given his sons information as to their proceedings, which led to the investigations of Davy and Wedgwood at a later period, but with the curious result that they could not "fix" the images they produced by means of silver salts, while the subjects of the present investigation show that if they were photographically produced, a fixing method had been discovered at an earlier date: if so, why was this important discovery lost to the world when old members of the Lunar Society were in existence?

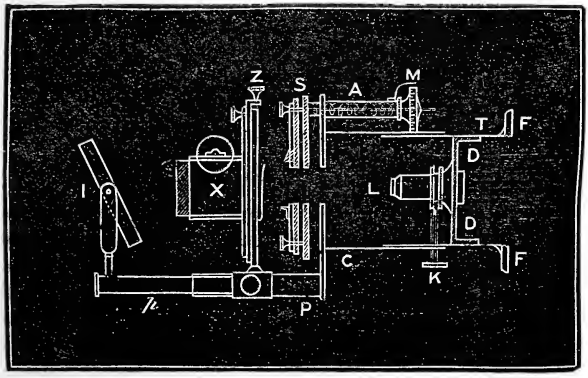
That the process, whatever its nature, was one of great importance, may be gleaned from the fact, vouched for by an existing document, that Sir W. Beechy, an artist of considerable standing, petitioned the members of the Lunar Society to discontinue their researches and not to divulge the secret of the process by which these paper pictures were produced, as he feared that if it became generally known the artists would be ruined. Could mere facsimiles, hand-produced by aid of a camera-obscura, give cause for alarm to such a sensible man as Sir W. Beechy? At any rate, Government is supposed to have exerted its influence to suspend this branch of Messrs. Boulton and Watts's trade, as in a letter addressed by Boulton to Lord Dartmouth (then Lord Chamberlain), he declines the offer of a pension for the person that held the secret, and states that the scheme would probably die out more quickly from the memory of Egerton if the idea of a pension was not broached to him.

This is the position of affairs of "the Watt photographs" mystery; and at the next meeting of the London Photographic Society an attempt will

be made to settle the question as to whether the discovery of photography is to date from 1780 or 1791, with an exchange of laurels from the head of France to that of Britannia; or whether the discovery is only "a mare's nest;"—we incline to the latter opinion.

The Question as to the Invention of the Triplet Lens.—Mr. Sutton has on several occasions since the appearance of the Jury Report on the Photographic Department of the late Exhibition, questioned Mr. Dallmeyer's claim as the inventor of the unsymmetrical triplet lens, stating that the idea had been taken from his own "symmetrical" described some years since; but lately he has gone a step further, and proves, by *a photo-lithographic copy* of a letter addressed to the late Andrew Ross, bearing date November 13th, 1858, that he likewise suggested the proper construction of an unsymmetrical triplet, that Mr. Dallmeyer had access to this communication, adopted his idea, but has modified his suggestions "for the worst." Mr. Dallmeyer retorts that he is no way indebted to Mr. Sutton, but that they are mutually indebted to Mr. Rothwell for the idea of a triplet; and that he (Mr. Dallmeyer) was the first *to produce* a lens of this construction, a lens admitted by practical photographers to be a valuable addition to their apparatus—a claim that cannot be denied; while it remains for Mr. Sutton to prove that the triplet lens, as arranged by him, *is superior* to the one already before the public; for, in all these cases, "the proof of the pudding lies in the eating," and a trial of the two modifications under parallel conditions will be the only way in which it can be satisfactorily determined.

Photography in its application to the Microscope again seems to be claiming the attention it deserves after a lull of some ten years. In the last number of this REVIEW a description was given of a "Patent" micrographic camera, invented by a Mr. Eden; but a letter appeared in the *Chemical News* and the *British Journal of Photography*, from Mr. Highley the optician, pointing out the practical shortcomings of this "patent" arrangement, and describing the construction of the apparatus he employs



for securing negatives of microscopic objects for his educational photographs for the magic-lantern. He points out the necessity of using a camera with a free range of adjustment from 12 to 30 inches, instead

of a rigid body, as in Eden's; and employing a "mount" for the lens, stage, mirror, &c., that allows of the following adjustment: namely, the lens being brought nearer to or further from the stage, according as it may be of long or short focus; fine adjustment for the object, with the means of registering the difference between the chemical and visual foci for each lens, *or object*, according to the medium in which it may be mounted; gymbal adjustments on the stage, in case the object should lie obliquely instead of parallel to the objective; a secondary stage for the condenser and polarizer, and a plane mirror or achromatic prism with universal motions for the illumination of the object, as shown in the annexed diagram. With high powers, the allowance for the difference of the two foci is best effected by means of the micrometer head adjustment; with low powers, the object-glasses themselves should be corrected. By reversing the arrangement of parts, micro-photographs may be taken by the same instrument.

In connection wth the question of a National Portrait Gallery, it has been suggested that M. Joubert's "burnt-in" photographs on glass might be made available; or positive transparencies on glass, sealed up between two plates of glass, should be employed, as being the most indestructible form of photograph, the negatives from which they would be produced being likewise sealed up between glass and kept in a place of special safety. Photographers are not yet agreed as to the best material for the substratum for the collodion film for dry plates. Mr. Glover advocates a weak solution of india-rubber in benzole, while Mr. Taylor declares for a very dilute solution of albumen, which is the medium recommended by Mr. Barnes in one of the earliest works on the dry processes.

Professor Emerson Reynolds calls attention to the value of the ammoniacal dichloride of copper for the precipitation of silver salts from waste solution.

Several physicists are again giving attention to the construction of actinometers that can be made practically available; the most promising of the arrangements being that suggested by Professor Roscoe of Manchester.

The British Journal of Photography, one of the oldest of the periodicals devoted to the science, which has hitherto appeared fortnightly, announces that in future it will be published weekly, and that its publishing department will be removed from Liverpool to London.

PHYSICS.

Defective Spectroscopes.—In a communication to the *American Journal of Sciences* (XXXIV.), Mr. Rutherford describes the spectroscopes now employed by Donati, Secchi, and Professor Airey, in their observations of stellar spectra, and points out objections to each form. Donati uses a large burning-glass, fifteen inches aperture, with a focal distance of sixty-two inches, not achromatised, and mounted equatorially. The cone of light passes through a fine slit before reaching the focal point; after crossing at the focus, it traverses a cylindrical lens; thence, after being rendered parallel by an achromatic lens, it falls upon a flint-glass prism of 61°; emerging from this, it is received by a small achromatic objective, and is

observed with an eye-piece magnifying twelve times, in whose focus is placed a bar moveable by a micrometer screw. Mr. Rutherford believes that the following defects exist in this apparatus:—1st. Absence of achromatism in the great condenser, on account of which only a small portion of the spectrum can be examined at a time. 2nd. Too much power in the observing telescope. 3rd. The uncertainty of bringing the micrometer bar and lines into contact, there being no illumination. 4th. The want of a flame-line in the field of view, to insure the detection of slight displacements of the spectrum. Professor Airey's instrument is objected to, on the score that the lines are only rendered visible by the existence of aberrations, which prevent fine definition. Secchi's spectroscope is a far more perfect one than either of the two former. The light of the great Roman equatorial passes through a slit at the focal point, then traverses a cylindrical lens, is next rendered parallel by another lens, and finally falls upon the prism, the latter is composed of four flint-glass prisms of 90°, cemented to five crown-glass ones of the same angle. The only objection to this form is the great thickness of the glass in the prisms, the consequent absorption of light, and the increased danger of heterogeneity of material. The author terminates his interesting paper by attributing the shortening of the spectrum, seen by Mr. Glaisher at a height of four and a half miles, to the absence of light, and also to the monochromatic nature of the blue sky, which at that altitude held but little vapour capable of reflecting white light.

Sound produced by Electricity.—Professor Thomson has recently observed a very interesting and peculiar phenomenon in connection with the discharge of a condenser through a galvanometer coil. In experimenting on the electrostatic capacities of some specimens of insulated wire intended for submarine telegraphic cables, he had occasion to discharge through a galvanometer coil a condenser consisting of two parallel plates of metal, separated by a space of air of about ·007 inch across, and charged to a difference of potentials equal to that of about 800 Daniell's elements. At the moment of each discharge a sharp and slightly prolonged sound was observed, which seemed to come from the interior of the case containing the condenser. It was at first thought that it resulted from the passage of a spark across the air-space of the condenser; but this was found not to be the case. Several other experiments were conducted with a view to ascertain whether a spark had been produced within the condenser, but all showed that no such development occurred. Hence the observer concludes that *a plate of air emits a sound on being suddenly subjected to electric force, or on experiencing a sudden discharge of electric force through it.* —*Chemical News*, October 24th.

Necessary Conditions of Molecular Motion.—The conditions under which the phenomena of molecular movements manifest themselves are various, and may be thus classified:—1st. In the solution of substances for crystallization or dialysis. 2nd. When the substance is melted, as in the process for purifying lead and antimony. 3rd. When the substance is subject to mechanical violence, as in the conversion of fibrous malleable iron into the brittle and crystalline variety by means of concussions. 4th. During chemical action. But few instances of this class have been yet recorded.

One of them is the concentration of copper, by burning the poor copper pyrites, in which process, after partial roasting, the outer rind of the ore is almost free from copper, whilst the centre of the lump contains a kernel composed of sulphur, which contains all the copper lost by the roasted envelope, often to the extent of 42 per cent. Another instance is that seen in the manufacture of white lead by the Dutch process. In the latter, during the formation of the several successive strata, it is found that (*a*) the impurities present themselves more abundantly in certain layers than in others; and (*b*) also that the remaining uncorroded lead is far inferior in quality to that first employed. From this it has been concluded that the molecules have changed places during the process of manufacture.—*See a Paper read by D. Zenner before the British Association at its late Meeting.*

Carbon as a Musical Sound-producer.—That bodies whose densities are similar vibrate similarly appears to be shown in some recent experiments of Dr. Phipson's. He found that when a piece of homogeneous wood charcoal, about a foot long and an inch thick, is suspended by a string and struck with a hammer, it emits a beautiful musical sound, resembling that produced by glass under like circumstances. An experiment upon a bar of aluminium gave the same results. The densities of the three materials are:—

Glass	2·49
Amorphous carbon	2·50
Aluminium	2·62

The resonance of glass lasts, according to Dr. Phipson, for about five seconds; that of aluminium about four seconds; and that of charcoal from one and a half to two seconds.

New Method of Measuring the Chemical Action of the Sun's Rays.—This has been discovered and recorded by Dr. Phipson. The discovery appears to have been accidental, and to have resulted from the effect of light upon a solution of molybdic acid. A bottle containing the latter in an excess of sulphuric acid was exposed to the sun for about three hours every day, and became bluish-green during the daytime, and again colourless at night. The experiment was several times repeated with the same result. There was no evolution of gas. It appears that during daytime a certain amount of molybdic acid loses one atom of oxygen, which combines with the water, and during the night this binoxide of hydrogen gives back its borrowed atom. Now, a weak solution of permanganate of potash destroys the greenish colour produced by the action of the sun's rays; and hence nothing can be simpler than the estimation of the actinic power by the quantity of permanganate required to remove the colour. The variation of the actinism is represented by curves similar to those of the barometer, which may possibly be related to them. Dr. Phipson thinks he may be able to employ the oxalate of peroxide of iron to obtain more rapidly the same results as those achieved with molybdic acid.—*Vide a Paper read before the British Association at Newcastle-on-Tyne.*

The Absorption of Gases by Charcoal.—The following is a summary of the observations of Dr. Angus Smith, F.R.S., upon this subject:—1. Charcoal absorbs oxygen so as to separate it from common air, or from its mixtures with hydrogen and nitrogen. 2. It continues the absorption of

oxygen for about a month. 3. It does not absorb hydrogen, nitrogen, or carbonic acid for the same period. 4. The quantity absorbed does not *entirely* depend on the condensibility of the gases by pressure. 5. At the temperature of 212° Fahrenheit, the oxygen leaves the carbon as carbonic acid. 6. Animal charcoal is a more powerful absorbent than wood charcoal. 7. When nitrogen and hydrogen are absorbed by charcoal, they diffuse into the atmosphere another gas, with a force sufficient to depress the mercury three-quarters of an inch. 8. The action of porous bodies is not indiscriminate, but elective.—*Philosophical Magazine*, No. 175.

A Substitute for Bisulphide of Carbon Prisms.—In a late number of the *Chemical News*, a correspondent, alluding to the newly-discovered mercuric-methyl which Dr. Frankland exhibited at one of the meetings of the Chemical Society, suggests its employment, instead of bisulphide of carbon, in the preparation of fluid prisms. We think the idea most valuable and original, and hope, if the thing is possible, to see the suggestion carried out. Mercuric-methyl has a high refracting index, a density so great that flint glass will float upon its surface, and withal it is not, like the bisulphide of carbon, exceedingly volatile.

Spectrum Analysis of Cæsium.—In the course of the controversy which is now being carried on between Professor Bunsen on the one hand, and Messrs. Johnson and Allen on the other, the former states that the method of separation of cæsium from lepidolite employed by the latter, though successful, could not be used when the percentage of the metal was small. There is a close correspondence between the results of the analyses of both German and English chemists; and although there were some apparent discrepancies in regard to the lines seen in the spectrum, these have been now disposed of. Bunsen admits that in one of his plates a few lines were introduced which were never seen during experiment, and whose existence was owing to a mistake of the printer. In other respects, there is a close accordance between the spectra of both chemists, as will be seen by the subjacent table :—

Readings on scale of lines seen by Johnson and Allen.	Same as seen by Bunsen.
75	25
80	30
82·5	32·5

The relation thus expressed between the two series is maintained down to the number 160 of the American scale, which corresponds to 110 of Bunsen's. Professor Bunsen also states that he and Kirchoff have observed the greater number of the supposed new lines of Messrs. Allen and Johnson, but owing to the difficulty of reproducing them they were omitted. It is not easy to distribute the shades of many of the weaker colours in chromo-lithographic printing. See the *Philosophical Magazine* for October ; and the *American Journal of Science and Art*, vol. xxxv. p. 94.

Properties of Electro-deposited Antimony.—Mr. George Gore still continues his experiments on this subject. In a valuable contribution to the *Chemical News* for November 28, he states that when a current of electricity is passed from two or three elements of Smee's

or Grove's battery through a solution of terchloride of antimony, by means of an anode of antimony and a cathode of platinum, a bright black amorphous metallic coating is deposited on the cathode; and if this deposit be scratched by a needle, it rises several hundred degrees (Fahrenheit) in temperature, sometimes with an explosion, and gives off a small quantity of acid fumes. The same phenomenon, but in a lesser degree, occurs when either the teriodide or terbromide is employed. But if the fluoride be used, the metallic coating is devoid of the heating property. The inner and outer strata of the deposit are in unequal degrees of cohesion. The cause of this very peculiar phenomenon still requires some explanation.

Laplace's Correction for the Velocity of Sound.—The accuracy of Laplace's discovery is supposed by Professor Tyndall to have been rather the result of accident than of proper and legitimate calculation. It depends upon a peculiarity of air unproved in his day, but which distinguishes it from most other elastic fluids. From Professor Tyndall's own researches he is led to conclude that air possesses no sensible power of absorption or radiation. But though air is neutral, other gases, as ammonia and olefiant gas, are capable of absorbing from eighty to ninety per cent. of the entire radiation from an obscure source, and they possess a proportionate absorptive power. From this and other conditions it follows that, "from the moment any molecule receives by the act of condensation an accession to its calorific motion, that motion is in part wasted upon the æther in which the molecule swings." Hence the conclusion, that the correction of Laplace is no longer applicable under such circumstances. The writer remarks, "Apart from other important consequences, it would certainly be an interesting and beautiful result, if, from a thing apparently so remote as the velocity of sound, we could deduce, *à priori*, the fact which has been now illustrated by nearly five years' experiments—that the elementary gases have no sensible radiative power, while the compound gases are endowed with this power in very different degrees."—*Philosophical Magazine*," November.

Change of Form in heated Wrought Iron when cooled in Water.—In a paper read before the Royal Society, by Lieut.-Colonel Clerk, some very interesting results are recorded. It is found that when an iron cylinder heated red-hot is plunged to half its depth in cold water, a peculiar contraction or constriction takes place, according to the thickness of the metal, either at the water level, or at a point about an inch above it. The constriction is supposed to result from the opposite motions of two portions of the cylinder, the under part tending to pull in the upper, and the upper to pull out the under. The under, contracting more powerfully, has the advantage, and so, pulling in a part of the upper, produces the peculiar contraction.

ZOOLOGY AND COMPARATIVE ANATOMY.

Reproductive Phenomena of Amœbæ.—In reply to Mr. Carter's last communication on this subject we have another paper from Dr. Wallich. He expresses his opinion that the so-called reproductive bodies described

by the former naturalist are most probably the same structure as those which he himself has termed *sarcoblasts*. There is no true circulation of vital fluid in the Amœbæ; the appearance of one is deceptive, and results from mechanical causes entirely. The current of particles tends toward the more prominent pseudopods, and is caused by the rush of protoplasm in that direction; the backward stream is only apparent, the deception being produced by the rushing of the outward particles past others which are at rest; thus producing the same phenomena as that seen when a railway carriage is moving at a great speed. "One series of young individuals seems to be derived from the conversion of each free sarcoblast into a polymorphous body, devoid of cilia or flagelliform organ, but provided from the first with a nucleus or contractile vesicle and a rudimentary villous organ." Dr. Wallich supposes that another set of new beings may "result from a similar conversion of each encapsuled nucleus into a polymorphous body, in which, besides the organs just enumerated, may frequently be seen two or three spherical masses undistinguishable from the sarcoblasts." A third and more abundant brood may be "derived from each separate granule of the naked mulberry-like nuclear masses." He thinks it would be idle to attempt an explanation of these various processes in the present condition of our knowledge, as the information required for their solution is far greater than any we now possess. He records having himself observed the transition from the *naked* to the testaceous condition in specimens of free Amœbæ preserved in glass cells. And, on the authority of Mr. Tomkins, he states that the animal of *Arcella vulgaris* has been seen to evacuate its shell and move away in the nude condition.—*Annals of Natural History*, No. LXXI.

Habits of the Caddis-Worm.—Dr. J. E. Gray communicated to the Zoological Society some time since, a letter which he received from Miss E. M. Smee in regard to the habits of these peculiar larvæ. The observations of this lady are of exceeding interest. Having been surprised that such creatures as water-maggots could build houses for their own reception, she determined to discover the extent of their capabilities in this direction. In order to do so, she removed some specimens from their cases, and supplied them with materials other than those found in their habitats; and the result of her experiment was, that with some materials the caddis-worms had made very perfect cases, but with others they were unsuccessful. When they were supplied with particles of an irregular outline, such as glass, amethyst, cairngorm, onyx, agate, coral, coralline, marble, shells, jet, brass-shavings, gold-leaf, silver-leaf, &c., they formed perfect cases. But when rounded substances, such as glass beads, were the only ones they could obtain, the larvæ were unable to proceed with their architectural pursuits. She tried them with pine-wood, but the oily substance it contained stupefied the worms and suspended their operations. They also failed when varnished or painted particles were used. They do not affect all metals indiscriminately; seeming to have a distaste for lead, copper, and tin. The greatest number of cases which any larva would make was five; the last always being brittle and badly cemented. A material which was rejected by one was distasteful to all. The more rapid the current of water in which they live, the greater the density of the particles employed

in constructing the case, as though the little beings understood the necessity for resisting the force of the water. They are somewhat fastidious, and prefer uncooked meat. When turned out of their cases, air-bubbles appear on the surface of their bodies, which in a rapid current cause them to float to the surface, when they die from exhaustion. "The caddises are so excessively pugnacious, that I am always obliged to keep each in a separate vessel. If that precaution were not taken, instead of peaceably constructing their houses, a fierce warfare would be carried on between them which would result in the death of the weakest party."

The Emigration of the Lemming.—The cause of the emigration of this animal (*Lemmus norvegicus*) has for a long while engaged the attention of naturalists. M. Guyon, in a note in the *Comptes Rendus* for the 7th of September, examines the following reasons of the periodic departures of the lemming:—

1. *A severe winter, which the animal has a presentiment of.*—If this were the case, the emigration would always take place on the approach of winter, but this year it took place in spring.

2. *The want or scarcity of food in the localities where it lives.*—The lemming feeds on lichens and mosses, and these were as abundant this year as on former occasions.

3. *The increased multiplication of the animal in certain years.*—This appears to be the most plausible reason, and may be adopted, till some better explanation turns up. The lemming always pursues a right line in its migrations, and neither rivers nor mountains oppose its progress. It swims across the rivers, and either ascends or goes around the mountains. But, doubtless, on this point there has been a good deal of the marvellous mixed up with the accurate. Most probably the direction depends upon the fall of the ground, so that the lemmings descend like water, from the mountains. In their descent, they meet at the base, and travel in serried columns through the country, their lines diminishing as they march onwards, owing to the influence of disease, and to the fact that various animals prey upon them. M. Guyon succeeded in bringing two (for the first time) to France.

Two Species of Entomostracæ new to Britain.—The Rev. A. M. Norman has lately added two new species of the genus Acantholeberis to our fauna. These animals have been already described by Leydig, Fischer, Müller, &c., but were never before observed in this country. *A. curvirostris* is remarkable for the peculiar uprightness of its head, and *A. sordida* for its deep blood-red colour. Both have been minutely described and figured in an important paper in the *Proceedings of the Tyneside Naturalists' Club*, vol. vi. part i.

Fleas Inhabiting the Sea-shore.—These insects have been observed in large numbers at the sea-side by Mr. T. J. Bold. It is surprising that animals which are so peculiarly suctorial and parasitic should be discovered in such localities, but Mr. Bold assures us that he has seen them "dancing about quite merrily between Hartley and Whitly, and at other times they have been noticed quite frequently from South Shields to Marsden." —*Ibid.*

The Ailanthus Silk-moth.—The *Ailanthus glandulosa*, or false varnish-

tree, was originally introduced into Canada in 1771, and now grows there successfully, being a hardy plant, and being indifferent as to the soil upon which it grows. Its present feature of interest is in respect to its being the food of the silkworm, which is called after it. This moth was introduced into Europe in 1856, and has been extensively cultivated in France, where it has been even more remunerative than the *Bombyx Mori*, to which it is related. The *Bombyx Cyrthia*, for such is its name, is the subject of a long memoir, written by Dr. Robert Patterson of the Botanical Society of Canada. In the spring of 1862 he received about fifty eggs from Europe, and these hatched out so perfectly that there were at least thirty-five worms developed, which produced as many large and fine cocoons. Having watched the processes of transformation and development, Dr. Patterson thus describes them :—The eggs are about the size of a large pin's head, of a yellow colour, large at both ends, and depressed in the middle, and give rise to caterpillars in from ten to fifteen days. When the worm first comes from the egg it is very small, and of a blackish colour. After casting its first skin it becomes more of a yellow colour, and during the third period it becomes white, owing to a peculiar mealy secretion. After the fourth moult the body assumes a greenish tint, the feet and last joint being of a golden yellow. In the fifth stage the emerald green becomes more intense, and the ends of the tubercles are of a marine blue. It now eats greedily, and grows rapidly till it reaches a length of from $2\frac{3}{4}$ to 3 inches ; it then becomes torpid, and, attaching a few leaves together at the extremity of a branch, it begins its cocoon. The silk is of a yellowish-brown colour, and is not unlike the appearance of a decayed leaf. The perfect insect has been long familiar to naturalists, in collections of Chinese butterflies. The expansion of its wings is about five inches ; head and antennæ greyish-brown ; thorax and abdomen, lighter grey ; wings, ash colour and grey, with a broad transverse band of lighter colour intervening. The males seek the females only under the influence of sunshine.—*Canadian Naturalist*, August, 1863.

The Habits of Pagurus and Adamsia.— Whilst dredging last July, Lieutenant-Colonel Wortley obtained two associated specimens of these animals, *P. Prideauxii* and *A. palliata*, and having brought them to London, and imprisoned them in a glass jar, proceeded to watch their habits. His results are very curious. After about three weeks the Pagurus lost its shyness, and commenced to eat. First it eat one piece of meat, which was dropped into the aquarium ; then "it ate a second piece ; but on my giving it a third, I was agreeably surprised to see it seize the piece with its large claw, and insert it into the expectant mouth of the Adamsia." . . . . . "Whenever I feed him, I see him feed the Adamsia as soon as he has had enough himself." "On two occasions of my dropping meat into the vase, at a time when the Pagurus was not hungry, he inserted his claw within the tentacles of the Adamsia, and jerked it backwards and forwards ; but the tentacles not closing, he appeared to decide that Adamsia, also, was not hungry, and rejected the meat altogether." We certainly think that Colonel Wortley has established the fact that a strong affection exists between the two animals, although we can hardly coincide with the following supposition. "He

(Pagurus) may be luxurious enough to appreciate the soft cushion which Adamsia makes for his back and chest, or he may find that the white worm-like tentacles of Adamsia act as a sort of bait to small creatures, who thus bring themselves incautiously within the reach of Pagurus' sharp claws."—*Annals of Natural History* for November.

Beetles new to Science.—Of Coleoptera, with long antennæ, found in the Amazons, Mr. Bates establishes two genera: Lepturges, of which he describes twenty-three new species; and Parœcus, whose species are not yet all described.

The Skeleton of the Sirenia.—From a comparative examination of the skeletons of these animals, and those of Pachydermata and Cetacea, Professor Brandt concludes that the Sirenia are not to be regarded as Cetacea, but rather as Pachydermata whose habitat is a purely aquatic one. The Halitheria, which are now fossil, may be considered, from the fact that they present traces of hind limbs, as the highest forms of Sirenia; whilst the Rhytinæ, from the absence of teeth in the adult, must be looked on as the lowest. Hence the Dugongs, from the possession of intermediate characters, form a connecting link between the Halitheriæ and Rhytinæ; the Manatees being collateral types related to such existing pachyderms as the tapirs. — *Memoir read before the French Academy*, September 7th, 1863.

Gases in the Swim-bladder of Fish.—In concluding his memoir on this question, M. Moreau observes:—The air in the swim-bladder of fishes presents a composition which in regard to the quantity of oxygen may vary under the following conditions:—(1) The oxygen is diminished or entirely disappears during asphyxia and other morbid states. (2) In the fish whose swim-bladder is open, as in that in which the organ is closed, the air is renewed without being borrowed from the atmosphere, and the rapidity of this renewal is in proportion to the activity of the fish. (3) The air newly formed presents a far greater proportion of oxygen than the ordinary air of the swimming fish, and a greater proportion of oxygen than is dissolved in the surrounding water. The experiments were performed in Paris on the fresh-water fish, and the others in Bretagne, Concarneau, in M. Coste's aquaria, which were placed at M. Moreau's disposal.—*Comptes Rendus*, November 16th, 1863.

The Classification of Gastropodous Mollusks receives the consideration of M. Gouriet who is dissatisfied with all existing schemes. In his opinion it is unjust to base any system of arrangement upon characters of the generative organs, as by doing so animals otherwise closely related are entirely separated. He seems to think characters of the respiratory apparatus afford a better clue to the true affinities of these beings. Nevertheless he objects to such expressions, now in use, as *tubulibranch*, which seems to imply that the gills are tubular and to those of *cyclobranch* and *inferobranch*, which he considers confusing. He says, the gills can only occupy three positions. Either (1) they are external; or (2) enclosed in a special cavity, and generally covered by a shell; or (3) they are simply protected by an incomplete covering. He suggests the adoption of the following terms to designate the three natural groups:—Exobranchia, Stegibranchia, and Endobranchia. The animals included under the first

may be further classified according as the gills are seated on one or other point of the surface, thus :—Epibranchia, when these organs are on the back (Doris, etc.) ; Peribranchia, when they are placed round the mantle (Glaucus, etc.); Hypobranchia (same as the old Inferobranchia) ; and Pleurobranchia, when they are placed upon the side, as in Pleurobranchus, etc. The order Stegibranchia is also divided into four sections : first the Stegibranchia proper (corresponding to Cuvier's *Tectobranchia minus*, the Pleurobranchs, and to the Scutibranchs of the same author) ; second, the Cyclobranchia, which are the same as Cuvier's ; third, the Heteropod Stegibranchia, which, like Carinaria, have the heart and branchiæ beneath a minute shell ; and finally the Ianthinæ, which have the gills semi-detached. The order Endobranchia corresponds pretty closely to the Pectinibranchs and Tubulibranchs, and is subdivided into two groups, the Turbinæ and Tubulæ. Each of the preceding orders is so related to the other, that in a schematic arrangement it would be impossible to group them in one line, or even in two or three parallel lines ; they should be placed one at each angle of a triangular figure. Were it not for Blainville's suggestion that some gastropods should rank among the Acephala, the term Cephalidia might advantageously be substituted for that of Gastropoda.—*Comptes Rendus*, vol. lvii. No. xx.

Vitality of Rotifers.—It has been frequently stated in works on physiology and comparative anatomy that wheel animalcules may be completely desiccated and allowed to remain in that condition for an immense period of time, at the end of which, if a few drops of water be thrown upon them, they are immediately resuscitated. M. Pouchet says, that if this be true, then the school of physiologists which believes that life is the result of the operation of the physico-chemical forces will have much to support it. He, however, denies that such vitality is preserved by rotifers, and supports his denial by the following experiments :—A series of tubes, two decimetres long and eight millimetres in diameter, and capable of containing ten cubic decimetres of air, were taken. After being dried, there were introduced into each tube two decigrammes of earth which had been taken from a dry spot and exposed for ten days to the sun, and for ten other days to the vacuum of a receiver. Each tube contained about fifty rotifers and eight tardigrades which were alive at the period of commencing the experiment. The tubes were now closed with the blow-pipe, and in some of them there had been placed small particles of lime, which were separated from the earth by a fold of cotton. One series of tubes, which had been exposed during the six hottest months of the year to the noonday sun, was when broken found to contain not a single living animalcule ; and, to judge from the shrivelled condition, the creatures must have been dead for some considerable time. A second series, containing lime, gave the same results in four months' time. Finally, when the animalcules were dried by more powerful physico-chemical agencies, the same result followed. M. Pouchet observes : " Observation and experiment unite in proving that the hypothesis of resurrections which was equally the wonder and amusement of the physiologists of the last century, should not find serious advocates in ours : like the doctrine of enclosure of germs, it has had its day."—*Comptes Rendus*, November 20.

Spontaneous Generation.—The controversy between Messrs. Pasteur and Pouchet on this question is not yet extinct, for we find a communication from the former in the *Comptes Rendus* for the 2nd of November, in reply to a statement of the latter made before the Academy in September. M. Pasteur clearly shows that Pouchet's experiments are only his own on a very much smaller, and less precise scale; and that in reality they bear out M. Pasteur's views, that there is no such thing as spontaneous generation.

Homologies of the Facial Bones of Fishes.—M. H. Holland makes the following statements in regard to these homologies, to which he has been led by a study of the embryogeny of fish:—(1) The five facial pieces, comprised in the temporo-maxillary wing, tympanic wing, the mandibular arch, form two distinct groups, which correspond to two primordial elements of the cartilaginous skeleton, visible during the entire period of embryonic life. (2) The group proceeding from the anterior cartilage is composed of the tympanic and jugal bones of Cuvier, and constitutes the true arch of the inferior maxilla, to which it is articulated by its lower portion. The posterior group is composed of the three bones called by Cuvier the *temporal, symplectic,* and *pre-opercular* bones, and constitutes the hyoïdean arch. (3) The mandibular arch, despite its division, constitutes a whole, which is homologous with the tympanic wing, and consequently with the *os quadratum* of birds. (4) Similarly the hyoïdean arch, notwithstanding its being compound, represents a single osteologic element, which corresponds to the styloid bone of mammalia. Its great development being due to the complex part it has to play in connection with the function of respiration; it supports a hyoïdean cornu of a compound character, and is connected with the opercular wing, and assists in the breathing movements. (5) The true temporal of fishes does not belong, as Cuvier supposed, to the hyoïdean arch;—the portion which he termed *mastoidean* is really the squamosal portion of the temporal.

The Nervous System of Mollusks.—M. Salvatore Trinchese lately presented a memoir to the French Academy upon the Anatomy of the Nervous Centres in Gastropods. We hardly think his assertions will be confirmed by future observations. He states (1) that the nervous system of mollusks is composed of the same elements as that of vertebrate animals. (2) That the medullary nuclei found in the æsophagean collar differ from one another in structure. (3) That in those types in which the centralisation of the medullary nuclei is most marked, the fusion only occurs in half the pedal ganglion, those in the upper and lower regions being quite distinct. (4) That the nervous element penetrates the substance of the smooth muscular fibres of these animals, and terminates in points.

The Anatomy of the Brain of Lepidosiren annectens.—There are few points in the range of comparative anatomy of more interest, or which have given rise to more controversy, than the anatomy of the Lepidosiren, of which two species have been carefully examined, *L. annectens* and *L. paradoxa.* Among those who have heretofore devoted themselves to this subject, we may mention the names of Owen, Bischoff, and Hyrlt. It is by some naturalists regarded as a fish, by others as a reptile, and certainly its characters partake so much of those of both classes that it is difficult to say on

which side it should be ranked. M. Serres is now completing a splendid memoir on the anatomy of *L. annectens*, and in that portion of it relating to the brain, he writes: "Like *L. paradoxa*, *L. annectens* has only four pair of cerebral nerves, which are from before backwards,—the olfactory, optic, trigeminal, and vagus. The common *motores oculi*, like those of the fourth and sixth pairs, are entirely absent." . . . "The brain is more like that of reptiles than that of fishes, especially of perennibranchiate reptiles, as Professor Owen very properly remarks. It approaches reptiles in the slenderness of its cerebellum, although the size of the restiform bodies, contrasted with the smallness of this organ, reminds one of these bodies in the cartilaginous fishes, of the Ray family in particular. It is related to reptiles by the depression of the optic lobe, and by the unity of this organ, which is always double and well developed in the osseous and cartilaginous fishes; by the large size of its pineal gland, which is so small in fishes, that in many families it is impossible to prove its existence at all; and finally, by the form of the cerebral lobes, which are entirely reptilian. Secondly, the brain of *L. annectens*, as to its base and sides, presents a cord more piscine than reptilian. The ichthyologic character is partly produced by the anterior pyramidal bodies which intersect each other below and divide above, so as to constitute a rudimentary trapezoid body like that of mammalia; it is also produced by the size of the olivary bodies, which is almost that of those in rays and electric fishes. Thirdly, the size of the hypophysis of *L. annectens* is like that of one of the rays; and even the isolation of the optic tubercles is another fact of the same kind. As regards the fusion and isolation of the optic masses, and as regards the grey pedicle which attaches them to the cerebral lobes, these are exceptional facts which remain to be confirmed by the examination of the adult brain of this animal.—*Comptes Rendus*, September 28th, 1863.

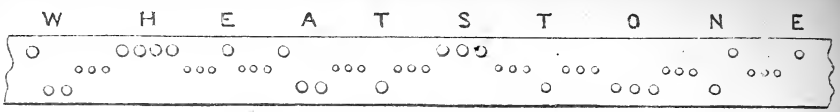
The Roman Imperial and the Crested Eagle.—Mr. J. Hogg, M.A., F.R.S., &c., read a very interesting paper, detailing the character of both forms, before the British Association at Newcastle-on-Tyne. The eagle of the "king of gods and men" is not crested; but Mr. Hogg's investigations into the ruins of Baalbec and Palmyra have led him to think that the eagle represented on many of the sculptures of these cities was copied from the *Aquila Desmursii*.—*Vide* Hogg's work on Baalbec, and *Transactions of Zoological Society*, vol. iv. part lxxvii.

The Development of Bothriocephalus latus.—Early in 1862, and also in July last, an opportunity of studying the development of this parasite presented itself to M. Bertolus, who since communicated his observations to the French Academy. The ovum of the Bothriocephalus which attacks man, requires a six or eight months' stay in running water before being developed into a larva. When it bursts from the ovisac, this egg consists of an ovoid, tough shell, of a dark brown colour, and filled with a granular amorphous material. At the end of a month or so, this vitellus is divided into cells. Then a germinal spot appears, and eventually the vitellus separates from the shell, leaving a space between the two. After about six months, the germinal area has involved the whole yolk; now the hooklets make their appearance in the embryo, which begins to show contractile movements. Finally, at the end of seven or eight months, a

small operculum is detached from the lesser end of the shell, and the embryo makes its escape. It is composed of concentric spheres. The external envelope is made up of large prismatic cells, arranged side by side, and covered with myriads of beautiful delicate cilia. By the aid of this apparatus the embryo swims rapidly in the water, but its movements soon slacken, and after a time they cease, and the coating of cilia disappears. Within this external envelope the second sphere moves freely, and armed at one of its poles with three pairs of hooklets just like those which are seen in the embryo of tænia. The outer membrane is formed of very pale nucleated cells. The strong resemblance of this embryo, on the one hand to the digenetic Trematrodes, and on the other to the Cysticerci, leads M. Bertolus to believe that, in order to complete its development, this young larva must encyst itself in the parenchyma of some aquatic animal. He is inclined to think that there is a decided relationship between the *Ligula nodosa* of Rudolphi, which lives in the conjunctiva of the salmon, and the *Bothriocephalus latus*, whose development he has described.—*Comptes Rendus*, September 21, 1863.

Influence of Infusoria (?) *over the Process of Germination in Plants.*—M. Lemaire has discovered, that if a few beans be placed on a moist sponge, numerous Bacteria make their appearance before germination begins, and are followed in about forty-eight hours by monads and vibriones. The same occurs if a soil be employed which has been previously brought to a red heat. If a small quantity of phenic acid, which prevents the development of Infusoria, be used, then germination will not take place.

NATURAL HISTORY.

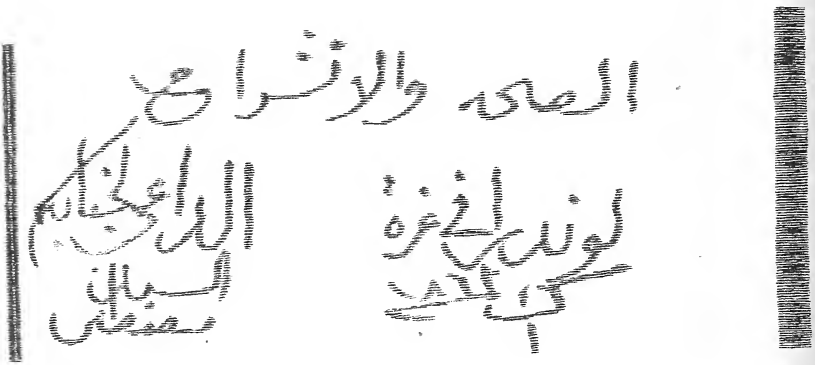


(Punched Slip prepared for sending.)

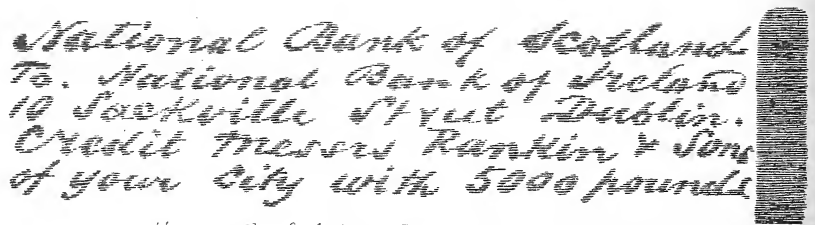
W H E A T S T O N E

(Message as received.)

Wheatstone's Automatic Printing



Message in Persian by Casellis Pantelegraph



Fac-simile of Autograph by Caselli's Pantelegraph.

SEND TWO BARRELS NICELY SELECTED SOON AS CONVENIENT.

Fac-simile of printing when 2 wires touch.

SHOWING THE PRINTING ONE WIRE BEING BROKEN

Fac-simile of printing one Wire being broken.

500 BAGS OF BALTIMORE SOLD AT SIX SHILLINGS PER CWT.

PRINTED BY THE BONELLI INSTRUMENT.

Fac-simile of printing when all wires are in order.
Bonelli system.

W West, imp.

ON PRINTING TELEGRAPHS.

BY R. S. CULLEY.

MUCH misconception prevails as to the progress telegraphy has made in England. It is very generally imagined that we are very much behind the age, and that the needle instrument introduced by Mr. Cooke is the only telegraph used in this country, because it is the only one the public has an opportunity of seeing. There cannot be a greater mistake. The needle telegraph has kept its place at our railway stations, and will keep it, perhaps, for many years, because of its simplicity, freedom from derangement, and the ease with which it can be repaired when out of order; but it is not used on any one important "commercial" circuit, even of the company which purchased the patent right.

The signals of the needle instrument, as is well known, are transient, and must be read off one by one as they appear, without a moment's hesitation. Though at the completion of each word the reader has the opportunity of saying that it is not understood, and obtaining a repetition, it may easily be imagined that if he give many "not understands," as they are called, the sender, who considers, naturally enough, nothing but stupidity prevents his signals being read, loses patience, and either reports the receiver as incompetent, or quarrels with him. Hence a tendency to guessing. These electrical quarrels are, in fact, one of the greatest sources of delay to messages, and damage to the apparatus, upon which the combatants vent their wrath as they cannot reach one another. Again, when an error arises, as it cannot be proved which clerk is to blame, it being impossible to determine whether the word has been wrongly signalled or read off inaccurately, neither the sender nor the receiver considers himself responsible. The feeling of responsibility is, however, amply secured by the printing system, for the signals are permanently recorded on the paper ribbon, or "slip," as it is technically called, and it is only necessary to refer to it to decide where the blame lies. The tendency to quarrel and talk is kept under control, for the slip, containing the whole conversation or quarrel, can be brought forward as evidence if required. And as the printed signals, if not perfectly legible at the first glance, can be studied, fewer errors occur in reading off. A

far greater amount of accuracy is therefore attained by the recording apparatus than by any system of transient signals.

The simplest printing telegraph is that of Professor Morse, of America. The alphabet consists of dots and dashes, and though purely conventional, is easily learned. It has been altered from time to time, in order that accidental irregularities in the distance between the dots and dashes shall not transform one important word into another; and although England at one time possessed an alphabet better suited to our own language, it was found necessary, on the establishment of direct communication with continental cities, to fall in with the system in use abroad, and the same characters are now adopted throughout the whole of the old world.

THE MORSE ALPHABET.

A	– —	J	– — — —	S	– – –
ä (æ)	– — – —	K	— – —	T	—
B	— – – –	L	– — – –	U	– – —
C	— – — –	M	— —	ü (ue)	– – — —
D	— – –	N	— –	V	– – – —
E	–	O	— — —	W	– — —
F	– – — –	ö (œ)	— — —	X	— – – —
G	— — –	P	– — — –	Y	— – — —
H	– – – –	Q	— — – —	Z	— — – –
I	– –	R	– — –	Ch	— — — —

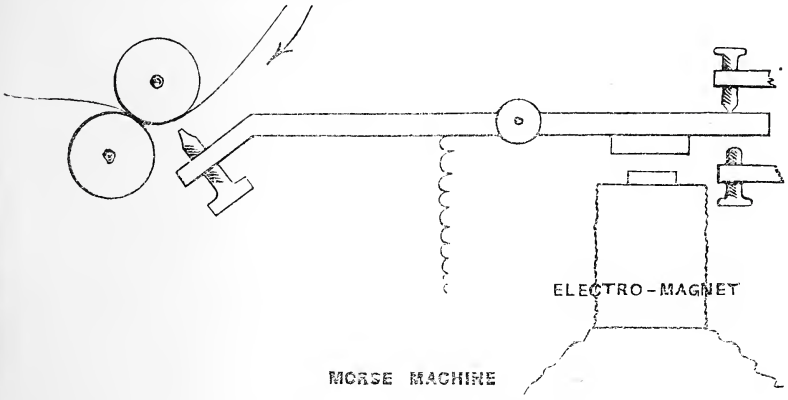
The Morse apparatus has been adopted almost universally. It is sufficiently simple to be worked by any lad of ordinary capacity, does not readily get out of order, and if deranged, can be set right with perfect ease. The dots and dashes, or "marks," as they are called, are embossed by a steel tracer or pencil upon a ribbon of paper, drawn forward at a uniform speed by clock-work; or written in colour upon the paper, by its being raised into contact with a small thin disk, covered with a peculiar ink. The latter arrangement produces more legible characters and requires less mechanical force than the embossing process, but needs a little more care.

The arrangement by which the electric current causes the pencil to touch and recede from the paper, so as to mark it, is this:—

In the upper roller of the pair by which the paper ribbon is carried forward is a groove; under the rollers is a lever, pivoted at its centre, carrying at one end the pencil or style, and at the other end a piece of iron, which forms the *armature* of an *electro-magnet* or horseshoe-shaped bar of iron, covered

with insulated wire. This armature lies close to the electro-magnet, but does not touch it, being held back by a spring.

When a current is caused to pass through the wire, the horseshoe becomes a magnet, attracts the armature overcoming the resistance of the spring, and presses the pencil upon the paper; but as soon as the current ceases, the iron loses its magnetism and the pencil is withdrawn by the spring. We give a diagram showing the principle:—



The duration of the current and length of the mark depend upon the sending-*key*. This key, in its simplest form, is merely a lever attached to the line-wire, or wire fixed from one station to the other, which, when at rest connects the wire with the earth, but when pressed places a battery between it and the earth, so as to send a current to the distant station.

The clerk taps out his message by means of his key, producing a succession of currents which act on the electro-magnet at the distant station, attracting its armature, and embossing or printing corresponding dashes and dots upon the paper band as it passes forward between the rollers, recording every movement of the sending-key.

On the conclusion of the message, if it is legible, the number of words is counted; and if correct, the receiver acknowledges it by sending back certain signals serving to identify it, followed by - — - — RT "right" (in America, O K, "all correct"). This acknowledgment appears on the slip of the sending station; and in case the message should not reach the person for whom it was intended, can be produced as a proof that it was duly transmitted.

The paper ribbon is cut in long lengths, and each roll is kept entire and unbroken, so that every signal may be registered in its proper place. If this were not done, the record

would be useless as a check, for dishonest clerks would be tempted to manufacture acknowledgments, and to destroy messages which they had neglected to deliver. The unbroken record prevents any such alterations and erasures.

Much has been said of the superiority of the American telegraphists, because they are able to read the Morse signals by the sound made by the electro magnet; and of the great saving in expense effected by dispensing with the paper slip. By this plan the advantage of the record is at once lost, and the Morse apparatus used as an acoustic instrument is not, in our opinion, either as rapid, or as accurate as the bell telegraph of the Messrs. Bright. It is not from a want of ability to read by sound that the system does not prevail here, for the English staff converse among themselves by almost inaudible taps upon the table, which has the merit of being a much more correct and rapid method than that adopted by the spiritual intelligences who favour us with their conversation, but who do not seem to have made much progress in this particular department of knowledge. Our clerks also talk by a slight movement of the forefinger or thumb, imperceptible to the uninitiated, which would be a wonderful assistance to clairvoyants and conjurers. Indeed, Robert Houdin employed some such means in his celebrated "second sight" experiments.

The Americans, however, because of a peculiarity in their system, can beat us in one particular. When in the open country, they can read what is passing on a wire by cutting it and putting its two ends into the mouth, and can reply by tapping them together, without any apparatus whatsoever.

In the earlier days of telegraphy, it was impossible to obtain legible signals at distances over two hundred miles, even in dry weather, and during fog or rain it was necessary to transmit messages by reading them off at an intermediate station, and forwarding them on afresh; so that a message from London to Glasgow would be repeated twice or even four times. Owing to the great improvements in insulation, distances of four hundred miles now offer no obstacle to direct communication in all weathers.

The Morse instrument has the great advantage of being capable of acting as an *automaton clerk*, and transmitting its own signals. The movement of the lever which carries the armature and style is limited by two screws, between which it oscillates with considerable force. It can, therefore, be easily made to perform the function of a key, so as to forward the message a second stage, where the same process may be again repeated.

By means of a series of such *relays*, direct communication is effected between London, Berlin, and St. Petersburg, or even more distant cities.

We have described the Morse apparatus in its simplest form, for the limits of our paper do not permit enlarging upon the contrivances for neutralizing the effects of induction in submarine cables, for cutting off the leakage from neighbouring wires, and for increasing the sensibility of the apparatus. It is, however, necessary to mention one point. As it is not possible to transmit to a great distance a current sufficiently strong to produce a powerful mechanical action, the current received from the sending station is made to act on a relay connected with as powerful a battery as may be required to set in motion the Morse apparatus.

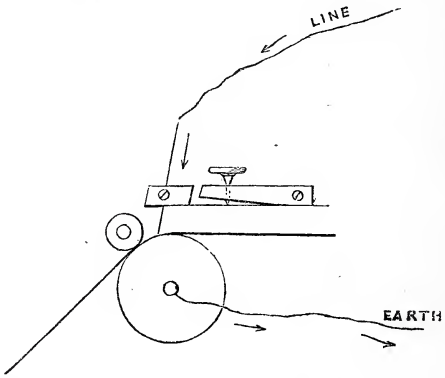
The speed attained by the Morse system varies with the nature of the despatch. Intelligence or news can be worked off much faster than private messages. A first-rate clerk has been known to send between sixty and seventy Stock Exchange messages per hour, but thirty to thirty-four words per minute is excellent work, the receiver, of course, writing for himself.

Owing to the facility afforded by the system of transmission by relay, or as it is called, *translation*, despatches can be sent to stations, on separate and distinct wires, at the same time by a single clerk. The debates in Parliament, Reuter's telegrams, and the other items of telegraphic news which appear in the country papers, are now frequently manifolded in this manner—to six, seven, or even more stations at the same time, and it would be quite possible, if it were desirable to do it, that a single clerk in London should supply every large town in the kingdom, at one and the same moment.

The printing telegraph first used here, and still partially employed, is, however, not that of Professor Morse, but an invention of Bain, of Edinburgh, founded on the chemical effects of electricity. When a current is caused to pass through the solution of a chemical compound, it decomposes it, or separates its component parts, in many cases producing an alteration in colour, either by causing the wire which conveys the current to be dissolved, or by separating a coloured solid substance from a solution previously colourless. Thus if a current be made to pass through paper soaked in iodide of potassium, iodine, a solid substance, will be separated at the wire connected to the copper of the battery, and a brown stain will be produced. Soak a sheet of printing-paper in a mixture of equal parts of saturated solutions of the ferrocyanide of potassium and nitrate of ammonia, diluted with an equal volume of water; blot it off and lay it smoothly on a plate of zinc or sheet of tinfoil, connected with the zinc of a Daniell battery of twenty cells. By

means of a flexible copper wire, connect a steel pen fixed in a wooden holder with the copper of the battery. The pen will now be found capable of writing in blue upon the prepared paper; but if either wire be disconnected from the battery so as to cause the current to cease, the pen will cease to mark, the power to do so being entirely dependent upon the passage of the current.

In Bain's telegraph the ribbon of moistened paper is carried forward by clockwork over a metallic roller, thus :—



A pencil of iron wire rests upon the paper, and is so connected that the positive current flows from the iron to the paper, producing signs similar to those of Morse.

The apparatus we have described is so simple and so easy to manage, that it will always be extensively used; nor is the peculiar alphabet as great a disadvantage as it may seem, for there is no real difficulty in acquiring a knowledge of it.

The instruments which print in ordinary letters by the pressure of inked type are extremely complex, and though, from the fact that each letter is formed by the simple pressure of a key like that of a pianoforte, it might seem they are easily worked, the fact is, so much skill is required to manage them and to print at a sufficiently high speed, that they are at present practically unremunerative. The most important instrument of this class is that of Professor Hughes, of New York. The apparatus at all the stations is precisely alike, and consists of a keyboard like that of a pianoforte, containing as many keys as there are letters, figures, and marks of punctuation to be printed. Connected with the keys is a set of movable pins arranged vertically in a circular frame, through the centre of which passes an upright shaft, kept constantly revolving by clockwork. Hinged upon this shaft is an horizontal arm, which sweeps round continually a little above the circle of

pins. If one of these pins be raised by pressing the key with which it is connected, the arm will touch it and slide over it in passing, establishing contact with a battery. A wheel on the edge of which the letters are engraved, is driven by the clock-work which keeps the horizontal arm in motion, and is so arranged that whenever the arm passes over the pin corresponding to a given letter on the keyboard, the letter itself on the type-wheel is opposite the paper. If the speed of the distant instrument can be so regulated that its type-wheel shall move in perfect accord with that of the sending station and if the paper ribbon at both stations be pressed upon the type at the same instant, the same letter will be printed at each. The pressure necessary for printing is produced by the current sent by the contact of the horizontal arm with the raised pin, which acts upon an electro-magnet and removes a catch or detent, permitting the wheelwork to raise the paper so as to touch the type. In order to obtain sufficient speed, it is necessary that the type-wheel should revolve at least 120 times per minute; and it will easily be understood that there is great difficulty in so regulating the receiving machine that at this high velocity it shall neither lose nor gain upon the sender. The adjustment is obtained by means of a vibrating spring which acts as a pendulum, and small differences in speed are adjusted before the printing of every letter by the machine itself.

M. Dujardin is engaged in perfecting a type machine on a different principle. Want of space compels us to omit the description of this and other methods of type-printing equally ingenious.

Methods of *automatic* transmission have been invented by Bain, Allan, Wheatstone, and others.

In Bain's system the characters are punched out from a strip of paper. The perforated strip passes over a metallic roller connected to the line-wire, and a spring or brush of wires fixed to the battery presses on its upper surface, so that as the paper moves forward the wire touches the roller through the perforations, sending a succession of currents which reproduce the characters at the distant station. A variation in the speed of the two machines simply alters the lengths of the signs, without in any way confusing the message. This system was worked some ten years since between Liverpool and Manchester, at a speed of about seventy words per minute; but owing to the defective insulation of the wires at that period, and the difficulty of punching the paper by the imperfect apparatus employed, it was discontinued.

Professor Wheatstone has now perfected an automatic telegraph founded upon the same principle, which bids fair to

be very successful, and admits of a vastly increased speed. In Professor Wheatstone's system the dashes of the Morse alphabet are represented by dots placed on the right hand of the paper ribbon, and the dots by similar marks on its left. Another line in the centre of the ribbon serves to form the spaces between the letters and words. This arrangement permits the perforating apparatus to be very much simplified, and to be manipulated with comparative ease. The apparatus by means of which the punched slip transmits the message is on the principle of the Jacquard loom. In it three wires are placed in a position precisely similar to that of the punches in the perforating apparatus. They lie on the edge of an eccentric wheel, which at each revolution presses them against the paper ribbon. If a hole be opposite the punch, it passes through it, touching the metal wheel and putting the battery in action. One wire sends positive, the other negative currents, which act upon separate electro-magnets in the receiving instrument, so as to reproduce the signs in ink.

It is obvious that a similar effect can be obtained by etching the Morse characters upon a plate of metal covered with varnish, or by writing them in insulating ink upon a piece of metallic foil or silvered paper; and by chemical decomposition, Roman letters, or even a sufficiently bold handwriting, may be copied from the foil upon a sheet of prepared paper, by ruling a series of lines across the two with metallic pencils, connected with each other and with a battery.

When the sending pencil is drawn across that part of the foil on which nothing is written, and which therefore conducts uniformly, the receiving pencil will produce a straight line upon the moistened paper; but when the sending pencil moves across the *writing*, the current will be cut off by the insulating ink, producing corresponding breaks in the line formed by the other pencil; if the two pencils are so connected as to be capable of being moved uniformly over their respective sheets, and if a series of parallel lines be drawn closely together by them, they will form a copy of the original in a species of line engraving or etching.

Many years since, Mr. Bakewell invented a copying apparatus founded upon this principle, by which fac-similes of handwriting were transmitted from London to Brighton as early as 1848.

The so-called Pantelegraph of the Abbé Caselli is really worthy the name it bears, for it transmits Chinese or Persian characters as readily as our ordinary letters, and reproduces a correspondent's autograph, or even his *portrait* if required. The despatch is written in ordinary ink upon silvered paper, and by a peculiar arrangement of batteries the copy is produced in blue upon a white ground.

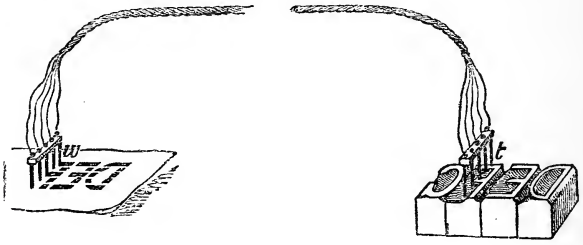
The practical difficulties of the system, simple as it may have seemed from the foregoing description, are very great. It is of course necessary that the markers at the two stations shall move with perfect uniformity, as if connected firmly together. The slightest difference in the speed of the two would be fatal. The colour is apt to run on the damp paper, and as the current on a long wire does not cease at the moment at which battery contact is broken, the marks as received are apt to be rather longer than those of the original, so as to merge one into the other.

The apparatus at all the stations is precisely similar. A massive iron frame carries a pendulum about six feet long having a very heavy iron bob, whose movements are controlled by electro-magnets, which attract it at each oscillation and hold it fast until the current which magnetizes them is cut off by a regulator clock, the going of which can be controlled with the greatest nicety without stopping it. The large pendulum, whose beats exactly correspond with those of the regulator, gives motion to two curved tables, one on each side, on which the prepared paper or original despatch is laid. The metal tracers or pencils are fixed above these tables in such a manner that they pass over the paper as it moves, ruling a line at each vibration of the pendulum. The pencils are connected with screws which move them the ninetieth of an inch between each vibration, so as to rule a series of lines a ninetieth of an inch apart. They cannot be arranged so as to pass over the paper in both directions without tearing it, and are therefore lifted alternately. To avoid loss of time from this arrangement, two despatches are transmitted at the same time, one while the pendulum swings to the right, the other while it moves to the left. The clocks at the two stations are kept in perfect accord by altering their rate during the progress of the transmission, in such a manner that a straight line which is ruled at the edge of the original despatch shall be reproduced on the receiving-paper. In the plate we give fac-similes of messages in Persian and in English, which were transmitted from Liverpool to London.

In Caselli's system the synchronism of the two sets of apparatus in correspondence must be *perfect;* and as only the ninetieth of an inch of the despatch is traced by one movement of the pencil, its transmission is not very rapid. Only one line-wire is required.

In the telegraph now working between Liverpool and Manchester, Bonelli uses a sufficient number of pencils, arranged in form of a comb, to copy the whole despatch by a single movement, and thus not only saves time, but, as perfect synchronism is unnecessary, avoids the necessity for elaborate arrangements for regulating the speed of the apparatus.

On the other hand, each separate pencil must have a *distinct* wire, perfectly insulated from the rest, so as to reproduce only that part of the drawing, or message, over which it passes. Thus, originally, when it was proposed to produce elaborate copies like those of Caselli, an enormous number of wires were needed. This idea was subsequently abandoned, and the number of wires reduced to eleven, and lastly, to five. The message is set up in ordinary type, and is placed upon a truck moving upon a miniature railway. The chemically-prepared paper is laid upon a metal plate, carried on a similar truck. Over the truck carrying the type (*t*) is fixed a species of comb the width of the letters, having five teeth, arranged in such a manner that when the carriage moves, the comb shall pass over the face of the type so as to touch their raised surfaces; and over the truck at the distant station is a similar comb, with the same number of teeth, resting lightly on the prepared paper (*w*). Each tooth of the combs is connected by a separate and insulated line-wire, so that when any one of the teeth of the sending-comb touches a part of the type, a current is transmitted, which produces a corresponding mark upon the prepared paper, as is shown by the diagram.



The trucks are started at the same moment by the release of detents connected with electro-magnets, and are drawn forward by weights.

When all the five line-wires are in good order the system admits of marvellous rapidity, and the fac-simile given in the plate will show that legible despatches may be forwarded even when they are partially deranged.

As the blue mark of Bain and Caselli is produced by the dissolving away of the iron pencil, the ferrocyanide solution is not applicable to Bonelli's system, for it is necessary the teeth of the comb should wear equally; the teeth are therefore formed of platinum, and the solution is nitrate of manganese, which does not act upon the platinum.

The inventors of the automatic systems consider that messages may be prepared by the sender himself, at his own office, and handed to the Telegraph Company simply for

transmission. It may, perhaps, be doubted whether merchants or their clerks will give sufficient attention to the preparation of the punched ribbon, or write so distinctly on the Caselli tablets as to produce a good working copy; so that it may always be necessary that the staff of the telegraph should prepare the messages for transmission. Still the advantages of the system are obvious. The capacity of each wire is vastly increased; and as there need be no limit to the number of clerks employed in the preparation of and the translation of the despatches, the rapidity of transmission may be urged to the furthest. Machinery preserves its superiority to hand labour even in telegraphing.

There is a limit to this rapidity. Induction lengthens the duration of each current, tending to connect the separate signals into a continuous line; and a contact of very short duration, unless aided by a powerful battery, is insufficient to charge the wire. These effects are not very apparent in short distances, but increase rapidly with the length of the line. It seems to us that, although greater accuracy may be attained, the telegraph service will not be as *regular* even as at present, if fast automatic systems come into use. The wires will always be subject to derangement; and supposing the work done by each wire is doubled, the stoppage of a single wire will delay double the number of messages.

For the public, the *safest* apparatus is that which employs one wire only, and which works at a low speed. The cheapening of rates, however, will not permit the profitable use of such a system, and certainty must be sacrificed to price.

The value of a particular system must be estimated, not by the beauty or the singularity of its effects, but by pounds, shillings, and pence; that is, its cost, the expense of working and maintenance, its speed, correctness, and freedom from derangement. Every system has its own special causes of error and its own special faults, which are not always those which unprofessional persons would suspect, although, perhaps, on no subject do the ignorant give opinions more freely or with more confidence.

So much attention is now given to telegraphy, and so much talent is devoted to its improvement, that it is difficult to imagine what the next ten years may produce. The apprehension of Tawell was in its day a wonder; but how inefficient the power of giving a verbal description of the murderer, compared with that of forwarding his very portrait!

HERRINGS AND HERRING-FISHING.

BY THE EDITOR.

"In 1861 there were in Scotland, and that part of England over which the Fishery Board have jurisdiction, 42,571 fishermen and boys engaged in the herring fishery. The total take of the year would give about 20,000 herrings for each of these persons, or near upon 900,000,000 for the whole."*

THIS is our text, and we trust it is one calculated to impress the reader with some idea of the vast importance of the subject upon which we write. The mere fact that in these countries alone, there are nearly as many hands employed in "shooting" nets, as the king of Denmark pays for the somewhat less profitable labour of shooting men, is in this century of civilization, of more than ordinary significance. Assuredly, it speaks well for British industry, and bears out fully the remark of Lacépède, that "le hareng est une de ces productions dont l'emploi décide de la destinée des empires." In one year, and on the shores of one nation, there was a multitude of these finny representatives of ocean life destroyed exceeding numerically the entire population of the globe. It is not, however, by a consideration of the quantity of these beings captured, that a true estimate of the commercial bearings of the circumstance can be arrived at. This can alone be reached by calculating the value in money of the fish thus caught during a single year. Let us suppose that, as an average, 800 herrings are equivalent to a barrel. Now, this number divided into 900,000,000 gives us the enormous quotient 1,125,000, as the total quantity of barrels produced; but, since a barrel of herrings may be said to be worth about twenty shillings, we have here the annual pecuniary produce of a single fishery amounting to above a *million* sterling! This is the fact to which we would especially direct attention, and which we apprehend deserves the grave consideration of those statesmen who are anxious to better the condition of our neighbours on the other side of the Irish Channel. When "antient writers" moralized upon the fable of the "Lion and the Mouse," they did not believe that so very improbable a contingency as that alluded to in the story was ever likely to occur. For us, the

* "Report of the Royal Commission on the operation of the Acts relating to trawling for Herring on the Coasts of Scotland." 1863.

herring is the mouse, and the English nation the lion. The herring fisheries have manned our navies, extended our commerce, and prevented the emigration of a population which, without them, could not have existed. The mouse has played its part; let not the lion forget the debt of gratitude which he unquestionably owes.

"Revenons à nos moutons;" we may say of the herring that its early history is involved in obscurity, a fate which it shares with many another benefactor to humanity. Mr. Mitchell,* relying on the authority of Anderson, supposes that herring fishing was in existence among the inhabitants of Scotland as early as the year 836. But inasmuch, as in the quotation from Anderson the term *fish* alone is employed, we are not warranted in assuming that herrings were the class of fish alluded to. Indeed, the earliest definite record which we find, warrants us in supposing that Yarmouth was the locality which historically had the precedence as a herring-station. Swinden,† in quoting from "Jeake's Charters of the Cinque Ports," observes :—

"And now by pregnant probabilities, it is my opinion very clear, that from the landing of Cerdick in anno 495—now 1124 years past—this sand, by defluxion of tides, did by little and little lift its head above the waters; and so in short time after, sundry fishermen, as well of this kingdom, viz., of the Five Ports (being then the principal fishermen of England), as also of France, Flanders, and the Low Countries, yearly about the feast of S. Michael the Archangel, resorted thither, where they continued in tents made for the purpose, by the space of forty days, about the killing, trimming, salting, and selling of herrings," &c.

Hence, we perceive that Yarmouth's reputation as a fishing-station is one which has existed for centuries, although we cannot with any approach to accuracy say when the world first became acquainted with the "Yarmouth bloater." About the periods of the eleventh and twelfth centuries we find frequent mention made of herrings, and Dr. Badham‡ informs us, that, "in 1290, part of the dried fish shipped at Yarmouth, in the victualling of a vessel to bring the infant Queen of Scotland from her Norwegian sire, were herrings, and these of course were cured." For a further history of the progress made by, and the obtacles opposed to, the herring-fishery, from the thirteenth century downwards, we must refer the

* "The Herring: its Natural History." By John Mitchell, F.R.S.S.A., &c. 1864. Pp. 130-31.

† "The History and Antiquities of the Ancient Burgh of Great Yarmouth." By Henry Swinden. 1772. P. 15.

‡ "Ancient and Modern Fish Tattle." By the Rev. C. D. Badham, M.D. 1854. Pp. 319-20.

reader to Mr. Mitchell's essay, in which much will be found to interest both fishermen and antiquaries.

The origin of the word *herring*, like the animal which is so named, is to some extent a mystery. McNicoll* gives us the two derivations, *heer* and *hairang;* the former being an old Saxon word, signifying a host, the latter an obsolete French word, of a similar meaning. Both derivations are most probably conjectural, but are nevertheless apt enough, as they refer to the enormous shoals in which these fish almost invariably appear.

Zoologically, the herring belongs to the great family Clupidæ, which embraces the kindred species pilchard, sprat, and whitebait. Of these, the pilchard is the only one, from its size, liable to be mistaken for the herring; it is, however, a much thicker fish, and its scales are fewer and of a larger size than those of the latter. In a natural history point of view, the herring has not been fairly treated. Till within recent years, when naturalists began to abandon romance-writing, and betook themselves to well-ascertained facts, the descriptions of the herring's habits were simply a combination resulting from the operation of imaginative minds on erroneously recorded evidence. Pennant,† and—strange to say—a later writer,‡ inform us, that the herring is a migratory animal, which at certain seasons comes in shoals from the Northern Ocean. Furthermore, that these armies are well organized and disciplined, and are not only controlled by properly appointed governors, but are led on by a vanguard selected from among the more dauntless members of the corps. That in this fashion the host traverses thousands of miles of ocean, till it meets its first check in the Shetland isles, "which divide it into two parts; one wing takes to the east, the other to the west of Great Britain, and fill every bay and creek with their numbers; others pass on towards Yarmouth, the great and ancient mart of herrings; they then pass through the British Channel, and after that, in a manner disappear." It is at first a little difficult to conceive how men can put forward such wild speculations in the absolute garb of matters of fact. Indeed, in reading Pennant's graphic description one is hardly led to doubt the veracity of the writer, so positive is the character of the statements made; yet nothing could be further from the real condition of things than Pennant's narrative,

* "Dictionary of Natural History Terms, with their Derivations," &c. By D. M'Nicoll, M.D. 1863. P. 211.—Consult also, "Encyclopædia Metropolitana," vol. xx.

† "British Zoology." 1776. Vol. iii.

‡ "Encyclopædia Britannica," article Ichthyology.

which, in point of fact, is from beginning to end unsupported by the faintest tittle of genuine evidence. The herring can hardly be said to be a nomadic animal, and though we may find the species abundantly distributed over a very wide area, it does not follow that the individual which is to-day observed upon the coast of Norway is that which at a later date is captured in the neighbourhood of the Shannon. We find Scotchmen in Van Diemen's Land and Canada; but that circumstance would not justify the conclusion that the individual discovered in either locality had proceeded to it from the other. Similarly with the herring, which, as a clever writer* states, "is a native fish, born and bred along our shores, which it never leaves for any length of time or space, although it has its periods of retirement and repose like other considerate creatures, and is in the habit of sinking for security, especially after spawning, into the deeper and more tranquil places of the sea."

The herring resides for a season in the deep sea, not far from the coast, and when about to spawn, it approaches the nearest shore for the deposition of its ova.† The following are some of the facts in support of this view.

1. Herrings of a certain size constantly frequent the same locality.

2. Herrings are often captured off the southern coasts long before they make their appearance on the northern shores. If they travelled in huge shoals from the arctic circle towards the equator, the reverse would occur. We should find them first appearing in the neighbourhood of the Hebrides, whilst the French coasts would present the latest specimens.

3. Particular fishing-stations are characterized by the quality of the herrings they produce. The fish caught in these localities are usually of the same description. Thus, the herrings got on the east coast of Scotland are of a quality inferior to those captured on the west. Did the herrings proceed in a body from the Northern oceans, we should (inasmuch as the more mature they are the better is their flavour)

* "Blackwood's Edinburgh Magazine," vol. lxxix. p. 522.

† This is the opinion of Mitchell (*loc. cit.*); Yarrell ("British Fishes," vol. ii.); and also of Wilson, who in his "Coasting Voyage round Scotland," remarks: "Another conclusion to which we have come, is that the herring is not a migratory fish in the proper acceptation of the term, but is merely subject, like most other species, to its periods of approach and recession to and from our shores, in accordance with certain natural instincts, connected mainly with the important process of spawning and the search for food. There is no season of the year in which these fish may not be captured along many portions of our Scottish shores."—Pp. 201–2.

expect to find those on the southern coast of a finer and richer quality than those taken further north. This, however, is not the case, for "the Yarmouth herrings are inferior in some respects to those of the north of Scotland." * It seems far more reasonable to suppose, that the quality of the herring is dependent in some measure upon the character of the sea or ocean in which it resides during the intervals between the spawning seasons. We are disposed to coincide in the view expressed by Wilson, † that there must be something in connection with the form and physical features of the protecting shores and sea-bed of an ocean, which influences the quality of these fish. The operation also of currents, of peculiar forms of vegetation, and of the geographical distribution of Annulosa and Mollusca, deserves the attention of those who are desirous of explaining the reason of the superiority which the fish of one locality possess over those of another. That it is not to be accounted for by evoking Pennant's theory is evident.

4. We have no evidence to prove that shoals of herrings have been observed in the extreme Northern Ocean. From an examination of the stomachs of the whales of Boreal seas, it has been found that herrings do not constitute the food of these monsters of the deep, which, on the contrary, devour only the molluscan, annulose, and cœlenterate creatures, which exist abundantly in mid-water. It is true that Crantz ‡ has described a small species of herring, found even north of Greenland; but this is a very different animal from our *Clupea harengus*. §

5. There have been no *reliable* statements made to the effect that the herring shoals have been seen approaching the Southern from the Northern Ocean.

6. It is a remarkable fact, that those species of whales whose food consists chiefly of herrings, are found in greatest numbers upon our own coasts. Now, if these fish were to be captured in higher latitudes, it is very improbable that

* Mitchell—"The Herring," &c.

† "Coasting Voyage," p. 199, *et seq.*

‡ Yarrell, vol. ii. p. 184.—"On the southern coast of Greenland the herring is a rare fish; and only a small variety of it, according to Crantz, is found on the northern shore. This small variety or species was found by Sir John Franklin on the shore of the Polar basin, on his second journey."

§ Badham, *loc. cit.* p. 321.—"The common herring seems unknown in Greenland. The Greenlanders' most common food is the *augmarset*, or small herring, near half a foot long, a kind of lodden, called by the Newfoundlandmen *capelin:* the back is dark-green, the belly silver-white; like herrings, they swim into the bays in such quantities, to lodge their spawn upon the rocks, that the sea looks black, and is ruffled or curled."

such cetaceous species as *Balæna musculus* would be seen upon our coasts.

7. In order to bear out Pennant's hypothesis, it would be necessary to show that the herrings travelled at certain seasons towards the North Pole also. For, those which we find in shoals spawn upon *our* shores, and not upon the coasts of Greenland. This being the case, how are the herrings transported to northern seas?

8. The authority of the celebrated Valenciennes* is in opposition to the migration theory.

The foregoing evidence is, in our opinion, sufficiently conclusive. The herring is not, then, a migratory fish, at least in Pennant's acceptation of the term. It is, nevertheless, of a capricious turn, and occasionally it leaves fishing-grounds where it has appeared before with the utmost regularity. The why and wherefore of its departure are not, as yet, understood, though many conjectures are afloat. The inhabitants of the Hebrides believed at one time that the fires employed in the manufacture of kelp drove the herrings away from Long Island. Others have attributed their disappearance to the effect produced by the report of fire-arms. Thus it has been gravely asserted that the cannon-firing at the battle of Copenhagen drove the herrings from the Baltic. The ancient Highlanders fancied † that they deserted a coast where blood had been shed. An amusing anecdote is told by Badham,‡ which would seem to show that the Irish herrings are not devoid of the Celtic character for sensitiveness; it is to this effect:—A new clergyman on taking possession of his living, had been heard openly to declare an intention of tithing the produce of the sea, at which imprudent notice the herrings took huff, and never again showed their scales there during his incumbency. It is the complaint of many of the fishermen of the present day, that the paddles and screws of steam-boats cause the herrings to leave their resorts; but this is clearly disproved by the fact, that in localities where (as on the Firth of Clyde) hundreds of steamboats ply daily, the herrings have not abandoned their old grounds. We can only suppose, in the absence of any more plausible explanation, that the reason of the herrings' departure is to be sought in the absence of certain forms of animal or vegetable life, necessary to their existence. The herring approaches the coast only for the purpose of delivering itself of spawn, and this function is performed twice in every year: first, in spring, and again in autumn. We do not imply by this that any

* "Histoire naturelle des Poissons," Cuvier & Valenciennes, vol. xx.

† Yarrell, *loc. cit.* p. 186.

‡ "Fish Tattle," p. 322.

individual herring spawns twice in the course of a single year. It is much more probable that the shoals of spring and autumn spawners are the produce of two distinct batches, and that the individuals of each series have reached the age of twelve months. There is much to lead us to believe that this period is all that is required by the herring in order to reach maturity. Hence, those hatched in autumn will spawn in autumn, and those hatched in spring will select the early months of the following year for the deposition of their ova. In approaching the coasts, especially if the weather be fine, the herrings come almost to the surface of the water, which is much disturbed and ruffled, and covered by hundreds of sea-birds, which scream and flutter and dive, as only sea-birds can, and thus afford to the fisherman a tolerably accurate indication of the appearance and whereabouts of the shoals. If, however, the water be rough, the fish subside to a lower level; this also occurs at night, save when the moon is shining, for then the herring comes to the surface. This is why, as Mr. Mitchell tells us, the fishermen glory in a moonlight night. Some are inclined to think that the result is due to the effect of light, and with this object have kept brands and torches burning at the surface of the water; but, as the last-named naturalist observes, "with no material advantage in so doing." The direction of the wind appears to have considerable influence over the rapidity of the herring's journey. When strong westerly gales prevail, the fishing season commences first on the west coast, and when the wind is easterly the east coast has the advantage; a circumstance intelligible enough when we conceive of the influence of powerful storms over the ocean currents.

Much has been said in regard to the food of the herring. One authority contends that it lives on *sea caterpillars;* another, that flies constitute its staple article of diet. According to the opinions of the recent Commissioners,* the herring lives upon small crustacea of sizes varying from that of a miscroscopic entomostracan to that of a common shrimp, and on fish, especially sand-eels. There can be little doubt that the herring is a far more omnivorous fish than the Commissioners imagine, and far less fastidious in his tastes. Yarrell† mentions an instance in which a young bass three inches long was taken from the stomach of a herring; and from the statements of others we are warranted in concluding that the herring will devour not only its own species and sprats, but also mollusks, medusæ, flies, and the ova and young of other fishes.

Besides the fry or young herring, this fish is found in three

* "Commissioners' Report," 1863, p. 28. † Vol. ii. p. 190.

other conditions. 1. *Maties*, or fat herring; 2. *Full herring*; and 3. lean or *Shotten herring*. The *Maties* vary in length from six to ten inches, and are known by the small size of the *milt* and *roe*, and the great quantity of fat which presents itself in the neighbourhood of the digestive canal. The *Full* herring has the milt and roe completely developed, and occupying nearly the entire cavity of the abdomen, the fatty matter having been absorbed during the development of the reproductive system. Finally, the *Lean* or *Shotten* herring is that which has deposited its ova or shed the fluid of the milt, and which is thus reduced to a state of exhaustion. In this state, the herring has hardly a particle of fat entering into the constitution of its tissues, which on this account are devoid of their normal flavour. It may at once be distinguished from the *Maties* by inflating the roe, which then assumes the size of those of the adult or *full* individual.

The spawning of the herring occurs at the periods before mentioned. The phenomenon does not differ in any essential particular from that observed in other fish. The female approaches the suitable ground, and expels the ova, which are surrounded by an exceedingly glutinous material, by means of which they become *firmly* attached to the surrounding objects, —rocks, stones, &c. Next, the milt fluid is shed upon the mass, and so fertilization is effected. The ova being, by virtue of their attachment to the stony sea-bed, preserved from the unfavourable influence of storms and such-like, gradually undergo their development into genuine fish. This process is generally completed in about a fortnight subsequent to the deposition, and it seems likely that in about ten weeks from the latter period, they reach a length of three inches.* At the end of the year they are perfect herrings. Few animals are more prolific than the herring; and were it not for the number of destructive agencies at work, it would be impossible to conceive of the strange consequences which would follow the reproduction of this creature. A single specimen weighing half a pound was found by Mr. Buckland† to contain 19,840 ova. Dr. Harmer‡ sets the number down as 36,000; but even on the supposition that the actual quantity is the mean of these two sets of figures, what an enormous number it gives as the offspring in one year of a single individual! Truly the strata being now deposited adjacent to our coasts will afford a rich treat in ichthyologic palæontology to future geologists. If

* Report of "Royal Commission," 1863, p. 27.

† "Fish-Hatching." 1863, p. 13.

‡ "Philosophical Transactions," lvii. p. 280.

Macaulay's New Zealander be at all of a scientific turn of mind, these herring-bone beds will supply him with an ample field for speculation!

It has been much debated whether the herring deposits its spawn upon sandy or stony bottoms. Some say in the latter; others (and especially those who object to trawling as injurious to the interests of herring-fisheries) assert that the former variety of sea-bottom is the one selected. On this point we have some very valuable evidence. Professor Allman's investigations into the character of the spawning-beds show us that the sandy bottoms (the only ones accessible to trawlers) never contain a particle of spawn, and that on the rocky and stony grounds the ova are deposited in the greatest abundance. He observes:* "It will be borne in mind that the only locality where any trace of spawn was met with, was in the neighbourhood of the May—on ground, in fact, which, in consequence of its rockiness, is never frequented by trawlers." Another naturalist† writing on the subject of the Ballantræ spawning-beds, which are some of the most important in the kingdom, states: "We went over it very carefully with an oyster-dredge during the better part of several days, ever and anon bringing up to the surface a portion of the natural bed or shingle of which it was composed, for minute examination. Over large tracts there was scarcely a stone or a pebble, from the size of a cracked nut to a cherry-stone, that was not covered and incrusted at least over all its upper or exposed surface, with a coating of eggs, forming a widely-diffused, but by no means thickened mass of ova, as the sands by the sea-shore innumerable." A good deal has been said about the vitality of the spawn being destroyed by the detachment of the ova. The vitality is much greater than has been imagined; for Professor Allman* states that specimens of ova underwent development in his aquaria after their removal from the sea-bed; nay, even though they had been kept for many hours in a scanty supply of water before he received them. Few facts in the natural history of the herring are so pregnant with interest as this one. We know now, that this valuable fish can be introduced into waters to which it has been up to the present a comparative stranger. Is not this a lesson for those who would develop the Irish herring-fisheries?

The enemies of the herring are legion, and embrace members of the three great vertebrate classes,—mammals, birds, and fishes.

* "Report" to the Board of Fisheries, upon the examination of the spawning-beds of the Firth of Forth.

† "Blackwood's Edinburgh Magazine," 1856, p. 524.

Of the first we have man at the top of the list, no mean destroyer; and next to him come the porpoises and whales. The gulls and gannets are the most destructive of the bird tribe which prey upon these creatures. But of all its foes, its own relatives are the most formidable. The cod, ling, hake, coal-fish, conger, and dog-fish devour the adult herrings, whilst the sea-trout devote themselves to the fry, and various species of plaice and soles prey upon the ova. It would be impossible to compute the numbers that are annihilated by these several voracious members of the piscine class; and while we wonder at the wholesale destruction of life which it involves, we cannot but look with reverence, on the surprising means adopted by the Great First Cause, to maintain a proper balance between the numerous and complex organisms that people the aquatic world.

A word or two on the capture of herrings. The means used for this purpose in Great Britain are of two kinds. Both may be looked on as modifications of a common method,—netting; one variety is called the *drift* net, the other is termed the *seine*. The former is simply a plain flat piece of netting, whose area is to some extent a matter of choice, but whose meshes should not exceed the square of an inch. To this weights are attached at one border and buoys or floats at the opposite one, the latter being connected by ropes, so that the net (opposing a flat surface to the water and standing in it vertically) may be submerged to the required depth. This net is carried out to sea and sunk in the locality in which the shoals are supposed to exist. After having been in the water for a certain length of time, the buoys are observed to sink, as though unable to sustain the net; this is then hauled in, and is found full of herrings, which, in endeavouring to force their way through it, have become entangled in the meshes. The seine net is of a somewhat similar form, but is employed differently. It has drag-ropes attached to it, and instead of being used in the open sea, it is more generally worked along shore in the following manner:—One end of the drag-rope being held on shore, the net is placed in a boat which is "pulled" out to some distance, the net being payed out from the boat, which, having described a semicircle, again touches land; the second drag-rope being now brought to shore, the men haul in both ropes (thus converting the net into a sort of bag which incloses everything between it and the land), till eventually vast quantities of fish of all kinds are captured.*

* Herrings have also been taken with an artificial fly and with bait (limpets). Two other methods of capture on the large scale still exist, though seldom employed,—the *cruive* and the *inclosing net*. The former is an appa-

The seining method seems to have created a good deal of jealousy among the drift-net fishers, and numerous have been the memorials and petitions presented to Parliament with a view to the suppression of this trawling system, as it has been improperly designated. We have carefully examined the evidence on this matter, laid before the late Royal Commission, and we can see no possibility of arriving at any conclusion other than that come to by Commissioners Huxley, Playfair, and Maxwell; viz., that the seining system is a fair and uninjurious one, and that it should by no means be trammelled by repressive legislation. We are sorry to see that a very eminent authority holds an opposite opinion; for, in this country at least, the "What's in a name?" doctrine has very little weight, and we do not desire to see an honest form of fishing suppressed, a contingency which might arise were others to set their faces against it. Let us also say we have a hope, that the late report will do much to remove the stigma which has so long been imprinted upon this important branch of our fisheries.

Viewed as an article of food, herrings may be said to be of four kinds. We have the fresh herring, the salt herring, the red or smoked herring, and the bloater. These, with the exception of the first, which is simply the herring in its unprepared state, are produced by various modes of "curing." In the preparation of salt herrings for the market, a good deal of routine has necessarily to be gone through before the *crown*-brand is affixed to the barrels; but in the main the process is as follows:—The fish having been conveyed to a convenient spot, they are in the first instance gutted; that is to say, the gills and digestive canal are removed by means of a sharp-bladed knife. They are then sprinkled with salt, and are ready for the barrel. In the bottom of the latter is placed a stratum of salt, and upon this is laid a stratum of herrings closely packed with their sides upwards; then follow alternate layers of salt and herrings till the barrel is full. Having been allowed to remain in this condition for some few days, the barrel on examination is found to contain a quantity of pickle in which the herrings are seen floating. The supernatant liquor is now poured off, an additional number of herrings, and a superficial stratum of salt are placed in the barrel, which is then closed and is ready for branding. The branding process

ratus composed of basket-work and is used on some of the Scotch rivers. The latter is adopted in Norway; the herrings are "inclosed in the bays or creeks, by means of the net being stretched across from side to side; thus inclosing the fish so as to prevent its egress. They are then caught by means of smaller drag-nets." See the "Report on the Herring Fishery of Norway," by Mr. Crowe, Her Majesty's Consul-general at Christiania.

consists in affixing to each barrel a series of letters, indicating the month and day in which the herrings were caught and cured, the name and address of the curer, and also the presence or absence of the gills and alimentary canal. Red herrings, or rather herrings which are about to be made red, are placed in barrels, with salt, and left for three or four days, just as in the case of the salt-fish. They are then removed and hung upon spits which contain about twenty herrings apiece. These spits are now plunged frequently in vessels of cold water, until the herrings have undergone the requisite amount of washing. Next, they are removed to the open air and dried, and are then ready for the "smoking-house." In this house they are suspended from the roof and are subjected to the influence of the smoke arising from wood fires made upon the floor of the chamber. Those red herrings which we ourselves purchase are exposed to the operation of the peculiar principles of the smoke for about ten days, but those intended for exportation often remain as long as three weeks in the smoking-house before being packed in barrels for the market. In the curing of bloaters a far more speedy process than either of those described is chosen. The freshly-caught fish are placed for a few hours in a very strong solution of salt and water; next they are put upon spits and plunged in cold water; and finally they are removed to the smoking-house, and submitted to the action of the smoke of small fires, which, having been kindled some time previously, emit but a slight quantity of fumes. This process extends over a period of about eight hours, and the herrings are then taken down and packed in the usual manner. Kippered herrings are merely modified bloaters.

Who first pickled herrings and who was the discoverer of the red herring, are questions which in the midst of the obscurity that herring enthusiasts have given rise to by their many controversies, will probably never receive satisfactory replies. The French claim the latter discovery, whilst the former has been yielded to the Dutch. Indeed, an English writer goes so far as to say that the word pickle itself originated in the name of the individual who first salted herrings. We are told that "Flanders had the honour of inventing the art of pickling herrings. One William Beukelen, of Biervlet, near Sluys, hit upon this useful expedient: from him was derived the name pickle, which we borrow from the Dutch aud German." *

Ere we conclude this brief sketch of "Herrings and Herring-Fishing," we would commend to the perusal of the reader interested in the subject, the valuable and lucid report presented by Her Majesty's Commissioners to the Houses of

* Pennant, vol. iii. Consult also Badham, *loc. cit.*, note to p. 319.

Parliament in 1863. There will be found therein a careful analysis of an immense mass of evidence, and the cautiously expressed opinion of men who have investigated the question of the herring fishery, in all its aspects. Let us add also, that those of our readers who thoroughly understand the nature of Mr. Darwin's theory of "Natural Selection" will detect in the evidence given before the Commissioners some facts which are powerfully corroborative of Darwinian doctrines.

Concerning the possible influence of certain modes of legislating on the subject of the herring-fisheries, we cannot do better in conclusion than quote some of the final passages of the document alluded to: *—

Consider the destruction of large herring by cod and ling alone. It is a very common thing to find a cod-fish with six or seven large herrings, of which not one has remained long enough to be digested, in his stomach. If, in order to be safe, we allow a cod-fish only two herrings *per diem*, and let him feed on herrings for only seven months the year, then $2 \times 210 = 420$ herring as his allowance during that time; and fifty cod-fish will equal one fisherman in destructive power. But the quantity of cod and ling taken in 1861, and registered by the Fishery Board. was over 80,000 cwt. On an average, 30 cod-fish go to 1 cwt. of the dried fish. Hence, at least, 2,400,000 cod-fish were caught in 1861. But if 50 cod-fish equal 1 fisherman, 2,400,000 will equal 48,000 fishermen. In other words, the cod and ling caught on the Scotch coasts in 1861, if they had been left in the water, would have caught as many herring as a number of fishermen *equal to all those in Scotland, and six thousand more*, in the same year; and as the cod and ling caught were certainly not one tithe part of those left behind, we may fairly estimate the destruction of herring, by these voracious fish alone, as at least ten times as great as that effected by all the fishermen put together.

When it is further considered, that the conger and the dog-fish probably do as much mischief as the cod and ling, that the gulls and the gannets slay their millions, and that the porpoises and grampuses destroy additional untold multitudes, it will probably be thought no exaggerated under-estimate if we assume that our fishery operations, extensive as they are, do not effect 5 per cent. of the total destruction of maties and full herring that takes place every year. . . . . If legislation could regulate the appetites of cod, conger, and porpoise, it might be useful to pass laws regarding them; but to prevent fishermen from catching their poor one or two per cent. of herring in any way they please, when the other ninety-eight per cent., subject to destructive agencies, are poached in all sorts of unrecognized piscine methods, seems a wasteful employment of the force of law.

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* "Report of the Royal Commission," 1863, pp. 29 and 31.

W.West, imp

Rusts

J.E.Sowerby, sc

MICROSCOPIC FUNGI.

RUSTS.

BY M. C. COOKE.

BEFORE entering more especially upon the subject of this paper, it may be advisable to attempt an explanation of a phenomenon of no uncommon occurrence in many groups of Fungi, and which is termed *Di-morphism*.

In the Uredines, or uredo-like fungi, as well as other of the *Coniomycetes* (in which the spores are the principal feature), the same fungus appears under two distinct forms, not necessarily mere differences of age, but so distinct that they have been regarded (and some are so still) as different species belonging to different genera, often far removed from each other, and bearing different names. One plant, for instance, sprinkled over the under surface of a rose-leaf, like turmeric-powder, has its mycelium, or root-like threads, penetrating the tissue, whilst bearing above its spherical golden-coloured spores. Its vegetative system is complete, and, apparently, its reproductive also; hence it seems to claim recognition as a perfect plant, and under the name of *Uredo Rosæ* was so recognized, until microscopical investigation determined otherwise. Thus it has been discovered that certain dark brown spots which appear later in the season are produced upon the same mycelium, and are indeed aggregations of more perfect and complex fruits of the same plant. Before this point was satisfactorily decided, the brown spores, which are borne on long stalks, and are themselves septate or divided (apparently or really) by transverse partitions into a complex fruit, received the name of *Puccinia Rosæ*. At this period, *Uredo Rosæ* and *Puccinia Rosæ*, or the yellow fungus and the dark brown fungus, were believed to be distinct and different plants; now, on the contrary, they are believed to be different forms of fruit produced by the same plant; *i.e.*, an instance of di-morphism. *Aregma mucronatum*, Fr., is the present scientific name of what is regarded as the perfect fungus, whilst the uredo form either bears the name of *Lecythea Rosæ*, Lev., or by some mycologists is rejected altogether as a spurious species.

During the summer it is not uncommon to find the leaves of some grasses, of the hop, of roses, and many other plants, covered with a kind of white mould, which appears under the microscope as a multitude of small transparent colourless cellules, generally attached to each other in a moniliform or beaded manner. These moulds were long known under the generic name of *Oidium*, to which genus the vine disease was also referred. More minute investigation, and more careful examination proved that these moulds were not in themselves perfect plants, but merely conditions of other fungi of a higher order, little differing it is true in external appearance to the naked eye, but offering material differences in structure under the microscope. Upon the white mould-like threads, spherical bodies are produced in the autumn, containing little sacs or asci filled with spores; and in this condition the plants are arranged under the genus *Erysiphe*, whilst the species of *Oidium* which represented their imperfect condition, are excluded from the system. Here, again, we have examples of *di-morphism*.

In the Journal of the Microscopical Society, Mr. F. Currey has detailed several instances of di-morphism which have fallen within his experience. In one instance he has shown that a small simple spored fungus, termed *Cryptosporium Neesii*, Ca., is only a state or condition of a fungus with compound fruit, belonging to the *Sphœria* section of ascigerous fungi, called *Valsa suffusa*, Fr. Both plants are exactly alike externally, but the perithecium, or flask-like receptacle containing the fructification, in one instance only holds naked spores, and in the other the spores are contained in little elongated vesicular bags or asci, which are packed within the perithecium.

Whilst writing this, one of the most wonderful books in a book-producing age lies beside me; it is the second volume of a work on fungi, by the brothers Tulasne; and this, as well as its predecessor, is devoted to this very subject of a multiplicity of form in the fructification of these plants. Illustrated by the most exquisite of engravings which art has ever produced, it also unfolds many a page in the history of these organisms, for which mycologists were not altogether unprepared. In noticing this work, one of our most eminent authors on mycological subjects quotes as an example *Dothidea ribis*, Fr., one of our most common fungi, which occurs in the form of little black shields on dead twigs of currants and gooseberries. Here we have, he says, naked spores (*conidia*) growing on the external cells of the stroma; we have naked spores of a second kind (*stylospores*) produced in distinct cysts (*pycnides*); we have minute bodies of a third kind (*spermatia*) produced

again in distinct cysts, resembling very closely similar bodies in lichens; and we have a third kind of cysts, containing the usual sporidia in sausage-shaped hyaline sacs (*asci*). Even here, however, we have not done with marvels; for if the stylospores are placed in water, they produce in the course of twenty-four hours conidia of a second order, exactly analogous to those which arise on the germination of the spores of the rusts and mildews which affect our cereals and other plants.

Further reference is also made to three species of moulds, which M. Tulasne has shown to be only varied forms of the mycelium of a species of *Sphæria* common to various plants; these moulds having been hitherto regarded as fungi perfect in themselves.

It is unnecessary to adduce other instances to prove that *di-morphism* is far from uncommon. In the Uredines, to which this paper is devoted, the genera known as *Lecythea* and *Trichobasis* are by some mycologists excluded altogether, as containing only species which are mere forms of more highly developed uredines, such as *Puccinia*, *Aregma*, and others. On the other hand, they are retained by those who possess a lingering doubt whether both forms may not be distinct, though developed from the same pustule. As the two forms are distinct in appearance, it will better answer my present purpose to treat them separately, notwithstanding my belief that, in a scientific point of view, the evidence is all in favour of their union.

Unfortunately, the first group of fungi to which I wish to direct our readers' attention, contains species but too well known for their ravages amongst graminaceous plants, especially the cereals. "Rust," as it is generally called, has a reputation little better than mildew, and it really deserves no better, for it is only another form of that pest of the farm, from the mycelium of which the corn-mildew is at length developed. There are two species very closely allied (doubtless only forms of the same species with different spores) which attack the leaves and culms of growing corn, and, bursting through the cuticle in the manner represented in Plate XII. fig. 9 (magnified), give a peculiar rusty appearance to the plant, as represented in fig. 8. One of these corn-rusts is botanically named *Trichobasis rubigo-vera*, Lev., or the "true rust *Trichobasis*;" the latter, which is the generic name, being a compound of two Greek words (*thrix*, a hair, and *basis*, a foundation), on account of the spores being at first furnished at their base with a short thread-like peduncle, which at length falls away (Plate XII. fig. 10). The other corn-rust is *Trichobasis linearis*, or "line-like *Trichobasis*," because the sori or pustules are linear, or lengthened out like a line; the

spores more elongated than those of the other corn-rust (fig. 12), and not so bright in colour. By intermediate forms these two rusts pass insensibly the one into the other, so that it is sometimes difficult to distinguish them. Both have the spores clustered together in the pustules, at first (fig. 11) attached by their peduncles, but they soon become free, and are scattered like rust-powder over the plant. Adverting to the attack of rust upon the wheat crops to an unusual extent a few years since, the Rev. M. J. Berkeley wrote as follows :—

We have seen rust more prevalent in white wheats, especially in the variety called Russian white, which has red smooth chaff, than we ever remember it. It is, however, confined to particular spots ; and while in one field not a single leaf is free, insomuch that a person walking through the wheat is completely painted with the spores, of a fine rust-red ; an adjoining field, separated only by a hedge, has not a rusty leaf. So long, however, as the rust is confined to the leaf, it is, we believe, perfectly harmless. The grain swells in spite of it, and the only effect is that the flag dies a little earlier, which is not undesirable when it is too luxuriant. If, however, it gets to any extent upon the chaff, much more if it attacks the seed itself, as is sometimes the case, it is very mischievous.

There is, indeed, a notion that rust is merely a form of mildew, and this may be true ; but if so, it is a harmless form. The true rust (*T. rubigo vera*) if a form of mildew preserves its own characters to the end, and merely presents a second form of fruit, a circumstance which is exceedingly common amongst the lower fungi. It may exist in company with the mildew, but it also more frequently is developed without a trace of mildew intermixed. As far, then, as its immediate effects upon the plant go, it may be treated as a distinct parasite, though advanced botanists may look upon it as offering a case of what they call dualism, which may be easily understood on a comparison with such plants as marigold and orache, which produce seeds of two different forms. Its ultimate effects may, indeed, be injurious, as, if it be really a second form of mildew, it is capable of propagating that pest. The case is quite different with *Trichobasis linearis*, which is in fact merely the young state of the mildew. When once that supposed species makes its appearance, it is quite certain that there will be mildew to a greater or less extent. While the spores of the one remain unaltered, though intermixed with the true bipartite spores of the mildew, the other exhibits every intermediate state of form and colour.

M. Tulasne, to whom I have already alluded as a high authority on this subject, is of opinion that all the species enumerated in this group or genus, are mere conditions of other species, and therefore excludes it altogether. Another genus (*Lecythea*), for the same reason, has shared the same fate.

It must not be forgotten that twenty-five species of rust belonging to this genus have been recorded as occurring in Great Britain. Some of these have yellow or yellowish spores ;

the rest have the spores of a decidedly brown colour. One of the most attractive of the yellow-spored species is that which appears on the groundsel (*T. Senecionis*), and a good notion of its external appearance may be gained from our figure (fig. 13). It is not always to be found without searching closely, for in some localities I have found it very sparingly, whilst elsewhere—as, for instance, on Wandsworth Common—I have met with it as soon or as late as there were groundsel leaves for it to grow upon. No spot or change in the appearance of the upper surface of the leaves indicates the presence of the parasite beneath; this is, however, often betrayed by the golden-yellow streaks which appear on the stem. Many a time and oft the boys in the semi-rural districts about town have marvelled and questioned each other concerning the reason why, in gathering "groundsel" for the little bird at home, I should be so particular, and pass so many promising plants, plucking here and there a leaf, and seldom collecting one which they consider eligible for the purpose. Collectors of minute fungi must expect to overhear occasionally even hints touching their sanity from those who, without the remotest idea of their mission, think they must be slightly "wrong in the head" to gaze so narrowly and intently, amongst nettles, groundsel, grass, or dry leaves, and only take an occasional fragment of a rotten stick, or two or three sickly leaves, carefully deposit them in their wallet, hat, or pocket, and then "move on."

It will be unnecessary to repeat what has been stated in a former paper on spermogones. It will be remembered that these organs are found developed in connection with some of the species of the present genus, as well as with the cluster-cups, or *Œcidiacei*. They consist externally of small conical elevations, pierced at the apex, which contain minute, cellular, linear bodies called spermatia, invested with a kind of mucous substance, that overflows with them from the orifice of the spermogone, like lava from the crater of a miniature volcano. The rust in company with which they have been found most plentifully, is that which covers the under surface of the leaves of the commonest of all thistles (*Cnicus arvensis*). The external form of one of these spermogones is figured (Pl. XII. fig. 16). The rust possesses, when fresh, a peculiar odour, which is said to resemble that of orange-flowers; whence was derived its name of "sweet-smelling rust" (*Trichobasis suaveolens*, Lev.). M. Tulasne writes:—"With respect to this species, it is, in my opinion, but the first form of a *Puccinia*, analogous to *P. compositarum*, D.C.: the spermogones with which it is mixed being very abundant, it ought to be placed

with that *Puccinia*. I should, perhaps, retain some doubts upon the legitimacy of this relationship, if it had not been my fortune to meet on another species of the same kind (*Puccinia anemones*, P.) spermogones perfectly characterized, and in which the colour, habit, and position would not allow me to hesitate an instant in attributing them to the *Puccinia*." In this species of rust the whole under surface of the leaf is covered with a purplish-brown dusty coating of the spores, from the numerous pustules which are produced (Plate XII. fig. 15). The plants, when attacked, have a paler and more sickly appearance; the leaves have a tendency to fold backwards at their margins, and thenceforth their growth seems to be determined. Sowerby, in his "British Fungi," says:—"Two or three sorts of flies are occasionally found dead on this plant at the time of the fungus being upon it, which is after wet weather in the summer, or early in autumn; being apparently tempted by its flavour, they over-eat themselves, or else are destroyed by some poison." This rust has spores resembling, in general characters, those of the yellow-spored series (Plate XII. fig. 17).

I have not thought it necessary to give figures of any other species, partly on account of the uncertainty existing in many minds whether they ought to be regarded as species, and whether they will long claim a place in the British Flora; and partly on account of the similarity which exists between them, at least so far as they are of interest to the microscopist only. There remain, however, two or three other species, to which I desire briefly to allude.

During the autumn of last year, whilst on a botanical excursion through a portion of Epping Forest, the "great bog" became a centre of some interest. Bogs are generally attractive spots to those who are in search of microscopic organisms. On this occasion the chief object of interest were the small brown pustules with which the upper surface of a large number of the leaves of the pennywort (*Hydrocotyle vulgaris*) was sprinkled. These pustules were brown, orbicular, regular, and in habit seemed to resemble rather those of most of the *Puccinicæ* than of a *Trichobasis*. The large, vigorous, and healthy leaves were not affected. Microscopical examination, at first incomplete, led me to the conclusion that it was a species of *Uredo*, which had been met with in France (*Uredo hydrocotyles*, Mont.); but a re-examination, to which I was prompted by Mr. Currey, led me to the conclusion that it belonged rather to the present genus; but I do not think that it can be associated with any species already described, notwithstanding its apparent affinity with the brown rust

found on umbelliferous plants, in which the pustules are invariably developed on the *under* surface. Under these circumstances, I have called it the Pennywort rust (*Trichobasis hydrocotyles*), whilst still doubtful whether it is not the same fungus as that described by Montagne, with whose description it agrees in everything, except what is implied by the generic name. It should not be forgotten, that the work in which Montagne first described this species was published when the genus *Uredo* embraced the present genus, which was separated from it by Leveille twelve years later; and it is possible that this species was included in a more recent work by the same author, in error and without re-examination, under the old name. An examination of authentic specimens of Montagne's plant would settle the point; but I know of no published collection which contains it. The characteristic difference between the two genera lies in the presence of a peduncle in the early stage of *Trichobasis*, and its absence in all stages of *Uredo*. Without wandering further into a subject which has not the merit of being very popular, let us away to some green lane in search of violets, and having found them, take a little of the brown dust from one of the small pustules on the leaves, upon the point of a penknife. Place this, with a drop of water, upon a glass slide, and make a record of what we observe.

The field is covered with the myriad spores of a rust of a nearly spherical shape, brownish in colour, and here and there one with a short transparent colourless stalk or pedicel. This is the violet rust (*Trichobasis Violarum*, B.), very common all through the summer and autumn, generally on the under surface of the leaves of violets, in woods and hedgerows. Should it so happen that the spores when placed under the microscope are found to be two-celled, it will prove that instead of a rust, or *Trichobasis*, being under examination, a brand, or *Puccinia*, has been found, which is almost equally common, and which may, without such a test, be easily mistaken for a rust. According to the theory of di-morphism, this is the higher form or complete fruit of the same fungus, which in its simple-celled state is called *Trichobasis Violarum*.

A similar circumstance may befall the student in examining the rust of labiate plants (*Trichobasis Labiatarum*, Lev.), which occurs on different species of mint, especially the water-mint, about the month of August. I have found a few of the two-celled spores of the *Puccinia* imbedded in the pustules of this rust almost constantly, whilst the one-celled spores are not uncommon in the pustules of what is regarded as the true mint brand (*Puccinia Menthæ*, P.).

The garden and field bean is liable in some seasons to become quite rust-coloured in consequence of the profusion of spores with which the leaves and stems are covered, from the bean rust (*Trichobasis Fabæ*, Lev.), which in like manner is considered as the simple stage or form of the bean brand (*Puccinia Fabæ*, Lk.). If the legumes are also examined, a few pustules will sometimes be found also on them. Beans thoroughly infected with this rust or brand are seldom of much service in either field or garden.

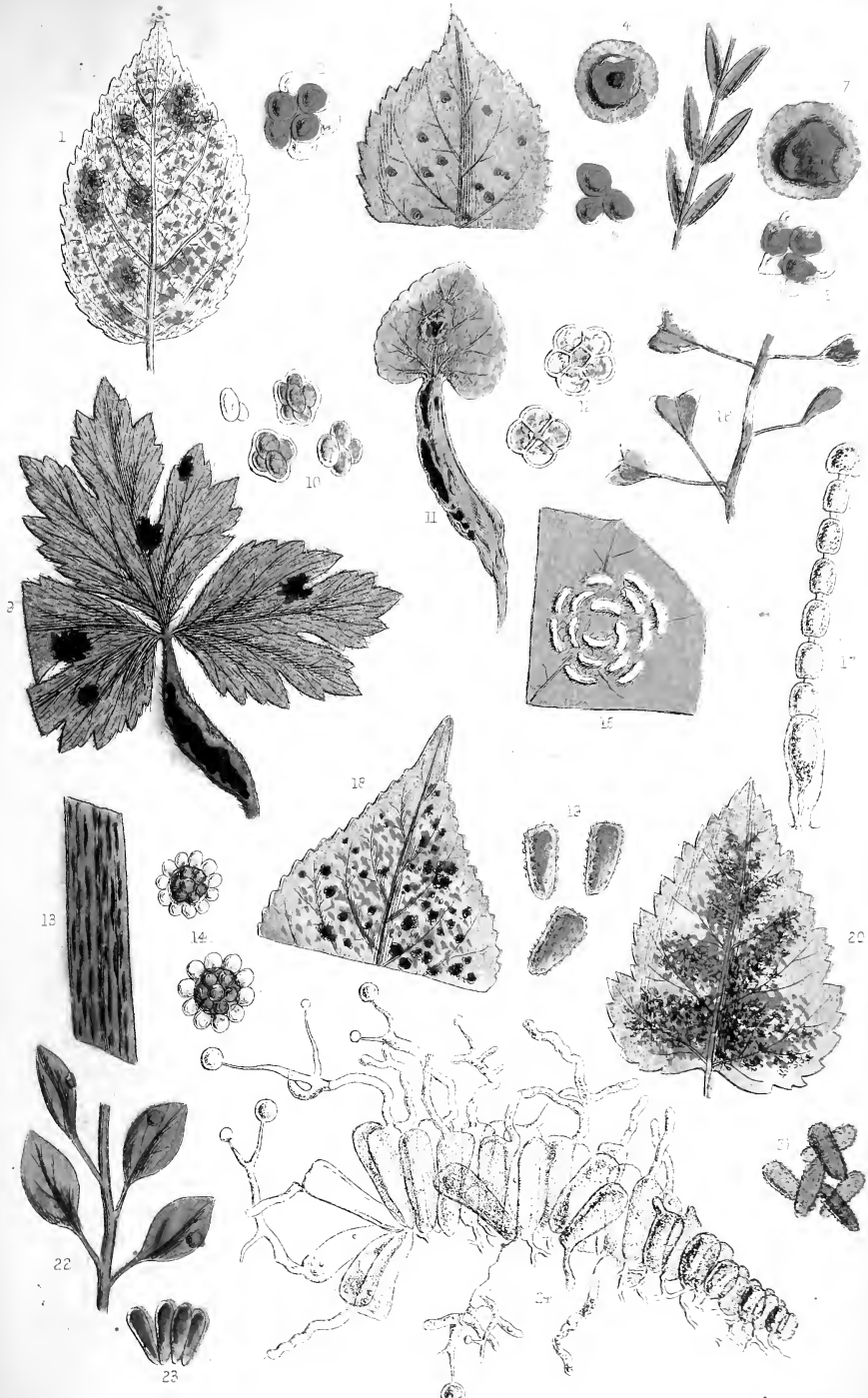
Beet-root, or mangold wurzel, is another example of garden and field produce which is subject to a similar visitation. This rust often has very red spores when produced on red varieties of beet. During last September it (*Trichobasis Betæ*, Lev.) was sent me on the leaves of the wild beet (*Beta maritima*).

All the species of *Polygonum* are exceedingly subject to the attacks of the Persicaria rust (*Trichobasis Polygonorum*, B.), which nearly covers the leaves, till the entire plants seem to be smothered in Scotch snuff. If it were allowable to affirm of any plants that they are martyrs to parasitism, such might be said of the Persicarias and their allies.

Amongst the remaining species of *Trichobasis* (the reader must pardon my using the generic name, as we have no equivalent), that found on the leaves of various composite plants is the most common (*Trichobasis Cichoracearum*, Lev.). It occurs on some thistles, on the saw-wort, dandelion, several species of hawkweed, and similar plants. The pustules are small and more diffused than in the species found on *Cnicus arvensis*, and they as often appear on the upper as on the lower surfaces of the leaves.

On umbelliferous plants three species are recorded; one with yellow spores (*Trichobasis Petroselini*, B.), another with a blistered habit, and brown, ovate, or oblong spores (*T. Umbellatarum*, Lev.), and a third with brown, obovate, or egg-shaped spores (*T. Heraclei*, B.), which is found solely on the cow-parsnip. The corresponding species of *Puccinia* to some of these species of *Trichobasis* are known, but in other cases, probability, or speculation if you please, occupies the place of knowledge.

Although the evidence against the retention of the species of *Lecythea* (as the genus is named) amongst Fungi as true species, on the ground of di-morphism, is even stronger than against the group just illustrated, I cannot pass them altogether in silence, especially in a popular treatise. Those who are residents in town, and yet possess their little plot of garden-ground, with only two or three pet roses, may have had the misfortune of seeing them smothered with a yellow blight.



W.West, imp.

J.E.Sowerby del.

Rusts

BRITISH MUSEUM
NATURAL HISTORY

This golden visitation, unwelcome as it is, may afford a subject for the microscope, and for a small space in my paper. At first there will not appear to be any important difference between the spores of the yellow series of the last genus and those of the present; but a closer examination will reveal one important distinction; viz., the presence of colourless elongated, abortive spores. The species are not so numerous by half as those of *Trichobasis*, even when three anomalous forms are included, which species are included by some mycologists in two other genera. One very common rust of this group has already been alluded to (Plate VIII. fig. 9), and which is known botanically as *Lecythea Rosæ*. A similar one is found on the bramble, and another on the burnet. All these three species are produced at first on spots which are afterwards more or less occupied by the long, many-celled spores of the dark brown brands called *Aregma* or *Phragmidium*, between which and the simple yellow spores of the rust almost every intermediate form may often be found in the same pustule. Thus, from the same mycelium as that of the rose rust, the rose brand is afterwards developed; whilst from the nidus of the bramble rust (Plate VIII. fig. 11) the bramble brand is also at length produced; and the successor to the burnet rust (Plate VIII. fig. 4) is the burnet brand. Besides these, a rust belonging to the same genus may be found on the leaves of the poplar, the spurge, and the common valerian, and two or three species on willows. It can scarcely have escaped notice, that the goat-willow is almost constantly afflicted with a rust on the under surface of the leaves (Plate XIII. fig. 1). This species will again come under notice in a later portion of this paper, as the summer spores of a truly di-morphous species.

One of the rusts separated by some botanists from this genus, is found (possibly most commonly) on the leaves of the raspberry; but during the past autumn I have met with it plentifully on the upper surface of the leaves of one or two species of bramble, and have never seen it growing on the raspberry, although in all descriptions of the species that is stated to be its habitat. Even to the naked eye this is so distinct, that no one could well confound it with any other. It appears very late in the autumn, and the spots are scattered at some distance apart from each other (Plate XIII. fig. 3); each spot or pustule forming a ring (fig. 4 enlarged) encircling a cluster of spermogones which occupy the centre.

Another rejected species (*Lecythea Lini*, Lev.) occurs on the little purging flax (*Linum catharticum*), forming small pustules on the leaves (Plate XIII. fig. 6); these burst irregularly, and remain surrounded by the remains of the ruptured epidermis

(fig. 7). The yellowish spores are subglobose (fig. 8), and in the first instance concatenate, or chained together like a necklace, which circumstance has been taken advantage of to place it, with one or two other species, in a separate genus.

The desire to include illustrations of all the genera of uredo-like fungi within these papers, so as to render them useful to any desirous of commencing the study botanically as well as microscopically, necessitates brevity in description, and selection in numbers, especially in this, the last to be devoted to them. Hence species may be met with in the fields and hedges not to be found in these pages, which are not intended as a flora, but rather as an introduction to one. The old genus *Uredo*, under which all the species alluded to in this contribution would then have been included, is now much less formidable in its dimensions; nevertheless, we must rest content with a reference to two or three species. Let the first bright day in May witness the student beside a cluster of plants of *Mercurialis perennis*, which it will not be difficult to find in many localities, and, on turning up the lower leaves he will meet with our first illustration of a genuine *Uredo*, in the form of yellow confluent patches, with a powdery surface (Plate XII. fig. 1). This will be *Uredo confluens*. By the way, the generic name is in itself suggestive, which it always should be in all instances, but unfortunately is not; it is derived from the Latin word *uro*, "I burn," and is peculiarly applicable in instances where the leaves acquire a blistered, burnt, or scorched appearance, occasioned by the presence of the fungus. The microscopical features of the spores of this genus are, briefly, a more or less spherical form, without any pedicel or footstalk. These spores are at first produced each in a separate cell, but when ripe become free, and are at times with difficulty distinguished from such forms as *Trichobasis*, unless the pedicels in the early stage of the latter genus are regarded.

A rare species in Britain is the oak-leaf rust (*Uredo Quercûs*), in which the sori or pustules are minute, and at first yellow, but afterwards orange. It occurs on the under surface of the leaves, and was, I believe, first found in this country by Mr. D. Stock, in the neighbourhood of Bungay, nearly five-and-twenty years since. That gentleman informs me that it was not at all uncommon, but always appeared on the young shoots which had sprung up from the trunks or roots of trees that had been cut down. I am uncertain whether it has been found by any one since that time in this country, although it is not uncommon in France.

The leaves of the common sorrel are often sparely sprinkled with the pustules of a rust (*Uredo bifrons*, Grev.), which derives

its specific name from the fact that the pustules, which appear on both surfaces of the leaves, are often opposite to each other (Plate XII. fig. 5). These pustules are generally seated on a discoloured spot (fig. 6 enlarged), and are surrounded by the remains of the ruptured epidermis. The spores are globose and brown (fig. 7). I have not met with any other *Uredine* on the sorrel leaves, though one having a similar appearance to the naked eye, is not uncommon on several species of dock.

The fern rust (*Uredo filicum*), which occurs on the under surface of the fronds of two or three species of ferns, I have never met with, and do not think that it can be considered common. It has been found in the west of England, on *Cystopteris*, and Sowerby collected it, probably not very far from London.

One of the most common is the rust found on the leaves of the enchanter's nightshade (*Circæa lutetiana*), sometimes nearly covering the under surface with its tawny snuff-coloured spores. The plant on which it is found is rather local, but the rust (*Uredo Circææ*) seems to abound wherever the plant on which it is parasitic flourishes. Another fungus of a very similar external appearance may be collected, more rarely, from the leaves of the same plant, but in this the spores are two-celled, or divided by a transverse partition. This fact is mentioned to guard against disappointment, should the spores be found to differ from the characters of this section, and to show that the microscope is essential to the study of fungi. The spores of the true Uredo are globose and without any partition (Plate XII. figs. 3, 4).

I may also observe that a very interesting species may be found on several species of St. John's wort (*Hypericum*). Another occurs on the leaves of some of the wild garlics (*Allium*); one is not uncommon on some of the stitchworts; another on saxifrages; another on willow-herbs (*Epilobium*), and one on the leaves of the cowberry. All of these have yellowish spores. A species with brown spores occurs on sea lavender (*Statice*). Space to write on my own part, and patience to read on the part of others, induce me to dismiss all these species with the bare allusion to them and the plants on which they may be found. Some of them may occur in one locality and some in another, and enough has perhaps been said to enable any one to place any that he may find in the proper genus, if not with the scientific name.

From the numerous instances I have met with of persons wholly disinterested in the subject, collecting, and making inquiries concerning the bright orange patches next to be referred to, I am led to conclude that most persons have, at least, seen them. These patches of orange-coloured powder

burst through the cuticle, and appear on the young branches of wild roses, extending sometimes for two or three inches in length (Plate XII. fig. 18), and form one of the most beautiful and obtrusive of the dust-like fungi. It is not confined to roses; but the meadow-sweet, on which it is also found, does not grow in localities where its parasite is so liable to meet the gaze of the ordinary wayfarer. The habit of this rust is more or less that of those which are associated with it. The pustules are not small and orbicular as in most instances in other groups (except *Polycystis*), but are large and irregular, and generally but few together or single. The spores are variously coloured, and have peduncles, or footstalks, of a greater or less length. In the rose rust these spores are profuse, but the peduncle is short (Plate XII. fig. 19).

Plants of the pea and bean tribe are liable to be attacked by one of these rusts, and in this instance the spores are so characteristic that no one could well confound them with any other. Externally it appears as an irregular brownish pustule, breaking through the epidermis as an impalpable powder, not unlike a pinch of "brown rappee" snuff. The spores are ovoid, with a very long peduncle, whence its name (*Uromyces appendiculata*). It appears on a great variety of plants, but from the peculiarity of the spores (Plate XII. fig. 21), is easily recognized. Our figure represents it on the leaf of a vetch (Plate XII. fig. 20).

An allied species, and a beautiful one, is to be found on the stinking iris (*Iris fœtidissima*), and another on the under surface of the leaves of primroses.

The pilewort (*Ranunculus ficaria*) we have already seen attacked by one species of microscopic fungi, and I have now to record the occurrence of another. Some plants appear to be destined both alive and dead to become the prey of others. The common nettle, for instance, as if in retribution for the annoyance it often occasions on account of its stinging propensities, has not less than twenty different species of minute fungi, to say nothing of coleopterous and lepidopterous insects, which make a home, sometimes upon its green leaves, and sometimes on its dead stems. We might almost state that it has a flora and fauna of its own. The pilewort too has many foes; but these are fewer in number, and mostly attack the living plant. The cluster-cups I have noticed already; some do not fall within the limits of this paper; but one, which is found in May and June, belongs to this genus. It appears like a purplish-brown powder bursting through blistered spots on the leaves and footstalks (Plate XII. fig. 22). The spores are small, and are, of course, provided with pedicels (Plate XII. fig. 23).

The under surface of the leaves of the white Dutch clover are often sprinkled with black spots, which are nearly round and very numerous. These are so many clusters of fungi belonging to a different section, in which the threads are the important feature. But another parasite is also found on leaves of the same plant, in which the pustules are far less numerous and regular, and are often found on the petiole as well as the leaf, distorting them and twisting them in various directions (Plate XII. fig. 31). This is the clover rust (*Uromyces apiculata*, Lev.), which is a parasite on numerous plants, being found also on the great water-dock and other kinds of dock. The spores are ovoid and brown, with a short peduncle (fig. 32). A very beautiful species occurs on the leaves of the ladies-mantle (*Alchemilla*), but hitherto I have not been fortunate enough to collect it.

A very interesting, though small group of allied fungi are included botanically under the genus called *Polycystis*, in allusion to the many cells of which the spores are composed. In the most recent work on British Fungi, approximating to a Flora, viz. "Berkeley's Outlines," only three species are recorded, whilst the most common, at least around London, is omitted in error; for it could scarcely have been unknown as indigenous to this country. This last is the crowfoot smut (*Polycystis pompholygodes*, Lev.), found on the leaves and petioles of the common creeping buttercup (*Ranunculus repens*), distorting them very much. The leaves and their footstalks when attacked, become swollen, as if blistered at first, and ultimately burst in an irregular manner, exposing a mass of blackish soot-like dust (Plate XIII. fig. 9), which on examination will be found to consist of the many-celled spores alluded to (fig. 10). Each of these spores appears to have a transparent outer membrane, either inclosing an unequal number, from two or three to five or six, distinct cells, compressed together into a spherical form by the outer integument, or the interior is divided by septa into as many cells. Each of these divisions contains a dark brownish endochrome, or cell-contents. As may be anticipated, the spores in all the species associated in this genus are interesting objects for the microscope. The species on the buttercup may be found through the summer and autumn on *Ranunculus repens*, especially whenever that plant is met with in very damp situations. We have seldom found the plant in any profusion without its attendant fungus. Another species of these many-celled smuts is not uncommon in gardens, on the sweet violet, attacking the footstalks of the leaves more commonly than the leaves themselves, and swelling and contorting them (Plate XIII. fig. 11). In general structure, the spores are very

similar to those of the last species, save that the cells are smaller, and a larger number are collected together. So far as I have yet examined the spores of this and the preceding species, they appear to consist of separate and distinct vesicles (probably spores), contained within a hyaline sac or outer membrane, and *not* to be a single spore divided into cells by numerous septa.

A species of equal interest (*Polycystis Colchici*, Tul.) is found on the autumnal crocus, or meadow-saffron (*Colchicum autumnale*). The spores approach nearer to those of the last than of the prior species.

A fourth species occurs on the leaves of rye, forming elongated parallel blackish lines (*Polycystis parallela*, B. & Br.). It has also been found on the leaves of some grasses, but does not appear to be very common.

Small as this genus is,—for I have named all the British representatives, its compound spores are beautiful objects for the microscope. It may not be altogether out of place to state, that I have found glycerine a very good medium in which to mount them for preservation, although I have usually employed balsam, for an idle reason which microscopists will appreciate. Deane's gelatine is more difficult of manipulation, or I may have been in fault, as well as my friends who have endeavoured to use it.

I well remember, in my younger days, before I had devoted myself to Fungi, and when I knew or recognized but little more than two or three kinds, how one or two little things puzzled me, as perhaps they may have puzzled others. I never could comprehend the mystery of smutted corn, nor understand what could cause the white rust. In a retired agricultural district, with no one to enlighten me, I continued to study such of the flowering plants as the locality yielded, and amused myself by making sketches of diseased leaves, and other like phenomena, which interested and puzzled me, and in fact, sometimes haunted me in dreams. One of these mysteries was the white, elevated, concentric spots on the leaves of cauliflowers and cabbages. In some years this singular appearance is very common. The leaves become depressed on the opposite surface to that on which white, elevated, irregular spots are seated, having a circular outline, but disposed in the manner represented in the plate (Plate XIII. fig. 15). These spots look like white paint or whitewash, not thrown on carelessly, but arranged and traced by an artist's hand. Sometimes one and sometimes twenty of these groups occur on the same leaf, and I now know that these spots are by no means confined to plants of the cabbage kind, but appear on numerous other plants belonging to very different

natural orders. For instance, some of the composite plants, spurges, spinach family, convolvuli, and allies of the garden pink, as well as others, suffer from this parasite. It is also so widely spread that it extends to the North American States in one direction, and the Falkland Islands in another. That it is a fungus, will be supposed from its mention here; but it belongs intimately to none that we have described, and is in itself, so far as Great Britain is concerned, genus and species in itself. The name bestowed upon it is *Cystopus candidus*, Lev., the relevancy of which will be seen as I proceed. This white rust is composed of a receptacle of thick branched threads, inclosing spores arranged in a beaded or moniliform manner, with a short connecting process between them (Plate XIII. fig. 17). The Rev. M. J. B. observes that the best way to observe the structure, is to make a thin vertical section, which will exhibit not only the necklaces of spores, but the obovate cysts from which they spring, and the curious, irregularly branched, often thick and nodose greenish mycelium. Besides this, there are also fine mucedinous threads which penetrate deeper into and amongst the tissues of the matrix, and resemble the more usual form of mycelium in the Uredines. If the ordinary method of taking off a portion from the pustule and placing it in a drop of water on a slide, be all the process of examination adopted, nothing more will be seen than myriads of disconnected, nearly globose, translucent, colourless spores, with no indication of the true structure.

This parasite appears also in patches (not orbicular or concentric, but dispersed) on the leaves, stems, and fruit, of the common shepherd's-purse (Plate XIII. fig. 16), and on the leaves of the goats-beard, scorzonera, and salsify, as well as on various other plants. Altogether it is a most interesting species, and has of late occupied again the attention of scientific men; but I cannot advisedly enter further into the subject here, although the whole paper might have been devoted with advantage to the history and mystery of its existence, and yet been by no means exhaustive.

Any one may make himself acquainted with the genus *Coleosporium* with but little trouble, which the acquisition will more than compensate. A summer stroll into any locality in which the common coltsfoot can be found, will be certain to prove sufficient. Let the spot selected be any station on the North Kent Railway, for those who reside in town, or even a trip to the Crystal Palace and a stroll in the grounds, and when the well-known leaves of the coltsfoot are descried, the under surface of the first leaf will doubtless give proof of the presence of the fungus in question, by the orange spores amongst its dense woolly hairs. Sometimes the leaf is almost

covered beneath with the bright orange-coloured dust. This is the coltsfoot rust (*Coleosporium Tussilaginis*, Lev., Plate XII. fig. 28), which may serve as a type of the rest. It may be observed that a species of cluster-cup, or *Œcidium*, with spores of nearly the same colour, is also to be found on the leaves of the same plant; but in this case the upper surface of the leaf has also corresponding purplish spots, and, what is of still more importance, the spores are seated in small fringed cups. The rust is common till the wintry frosts have set in, and is far more conspicuous than the cluster-cups. A kind of di-morphism prevails in all the species of this genus. Some of the pustules resolve themselves into a kind of powder, whilst others remain entire and solid. Generally there is the largest proportion of globose, dust-like, free spores, produced in the earliest developed fungi, whilst they become more rare towards the close of the season. The permanent spore-spots consist of obovate cellules placed side by side, each of which is divided transversely by three or four septa, and is filled with an orange-red endochrome (Plate XII. fig. 29); the exterior being enveloped in a kind of mucous layer. The arrangement of spores when packed together in the pustule is shown in Plate XII. fig. 30, from an allied species. When these spores germinate, which they do with great readiness, each division emits a long tube, which generally remains simple and undivided, and from its extremity is produced a reproductive body of an obovate or nearly kidney-shape. These filaments are about $\frac{1}{120}$th of an inch in length, of a colourless transparent membrane, along which the orange-red contents of the spores pass into the newly-formed sporidia, or reproductive bodies by which they are terminated. Most of these reniform sporidia disengage themselves from the filaments on which they are produced, and either elongate themselves into a simple and uniform filament, or swell at the extremity as if to reproduce a second spore. If the newly-formed sporidia do not become free, they increase the length of their primitive filament, which by a frequent repetition of the process becomes a tube swelling out at unequal distances.

The summer spores, or pulverulent spores of the first generation, which are analogous to the Uredo-spores of *Aregma*, are also capable of germination, for, if placed in favourable circumstances, they will develop very long filiform processes, which either remain simple or become more or less branched, but always nearly uniform in their diameter. M. Tulasne states that he has observed this germination many times, though we have been less fortunate.

Of the six species of this genus known to occur in Great Britain, the majority may be commonly met with. That very

widely-diffused plant, the wood cow-wheat (*Melampyrum pratense*), known well to all amateur botanists for its pertinacity in drying black, and presenting anything but an inviting appearance to claim for it a place in the herbarium—also becomes the matrix for the development of a member of this genus; *i. e.* the cow-wheat rust (*Coleosporium Rhinanthacearum*, Lev.), and which is found on other allied plants, as the little eyebright (*Euphrasia officinalis*), &c. (Plate XII. fig. 24). In colour and habit it resembles the last-named species, and its free, echinulate spores (Plate XII. fig. 25) form a pretty object for the microscope.

Another equally common species is found inhabiting the leaves of the sow-thistles (*Sonchus arvensis* and *S. oleraceus*), and in the autumn may generally be found on either of those plants, presenting the appearance delineated in our plate (Plate XIII. fig. 26). The permanent spores resemble in many points those of the first species, as will be seen from the figure from De Bary's treatise on this subject (Plate XII. fig. 27). This is certainly one of the most showy of uredinous fungi, and could not be well overlooked.

The butter-bur rust (*Coleosporium petasites*, Lev.) and the Campanula rust (*Coleosporium Campanulæ*, Lev.) are found, the former on the leaves of the butter-bur, and the latter on those of the harebell and other *Campanulæ*, less frequently. We have, however, indicated sufficient, since their great similarity in unprofessional eyes will furnish, in one or two species, all that is desirable for the microscopist.

Unless a similar plan be adopted for examining the species of this genus to that recommended for the white rust, it may result in disappointment; for the slight attachment of the joints to each other will otherwise present only a mass of simple echinulate cellules, if a portion be only removed from the leaf on the point of a lancet. Any person possessed of the cardinal virtues of microscopy—patience and perseverance—will be rewarded in this instance; whilst those who are deficient will lose an object worthy of the virtues they dare not boast. But few instances have occurred in this and the preceding papers in which the exercise of any great ingenuity or application has been called for; the most juvenile or truest tyro at the microscope may see for themselves much of what has been indicated, whilst a few opportunities have occurred for more practised manipulists to prove that they are neither juveniles nor tyros.

It can scarcely be too great an assumption to suppose that every one is acquainted with the goat-willow (*Salix caprœa*), or that every schoolboy knows the birch (*Betula alba*). It may be proceeding a step too far to affirm that all who know

these trees well enough to distinguish the one from the other, will have observed the under surfaces of the leaves of both sprinkled with a golden dust, during the summer months, and which are the spores of a parasitic fungus. So common is this orange-coloured powder on leaves of the trees above-named, that we can hardly believe any one to have had a branch of either in his hand and not observed it, provided any leaves adorned the branch in question. What this parasite is, and what its associates, it is our province to endeavour to explain. Our figure (Plate XIII. fig. 1) represents a leaf of the sallow or goat-willow, with the under surface exhibiting yellow patches, consisting of spores, which are magnified in the next figure (Plate XIII. fig. 2). This exceedingly common rust is termed *Lecythea caprearum*, Lev., when in the condition figured; but in reality this is only the summer stage, bearing the summer fruit of *Melampsora salicina*, which latter attains its mature development on the same leaves in the succeeding winter or early spring. Of course this latter remark applies to the fallen leaves, for at this period all the willows and other deciduous trees are bare. But the leaves, before they fall, give evidence of the parasite at work; and if the collected decaying mass of rubbish at the base of sallow bushes be examined about March, these leaves will be found bearing upon them mature heaps of elongated, wedge-shaped spores, closely packed side by side, and which, whilst still adherent, may often be found in active germination, as represented in an allied species at the bottom of our plate (Plate XIII. fig. 24). This phenomenon consists in the production of cylindrical tubes, more or less elongated, from the upper extremity (rarely from the base) of the prismatic spores. These tubes are straight or twisted, simple or forked, and each of them becomes divided by transverse septa into four unequal cells towards their apex, from each of which is produced a spicule bearing a sporidium, or spherical secondary fruit, in the same manner as in the genera *Puccinia* and *Aregma*. It should be observed, that the winter spores of this rust are borne on the opposite surface of the leaves to the summer spores: for whilst the latter are developed from the under surface, the former are found on the upper. This being also an instance of di-morphism, the summer condition, when spherical spores are produced, should not be regarded as a distinct plant, and the name of *Lecythea caprearum* does not merit retention in the list of fungi.

There are five species of this interesting group, or genus, found in Great Britain, to the residue of which we may only briefly allude. It has already been stated that, in summer, the yellow spores of a rust are found on the under surface of

birch-leaves. These must be sought on the young twigs or suckers, proceeding from the stumps of trees which have been cut down; pale discoloured spots on the upper surface of the leaves indicate the presence of the rust beneath. This is the *Uredo betulina* of old authors (begging their pardons, for some of them still live), the *Lecythea longicapsula* of more recent times, and the summer spores of *Melampsora betulina*, according to M. Tulasne and his disciples. When fresh, it is reputed to exhale a faint odour, as of the primrose. During the winter and spring months the wedge-like spores of the second crop are matured on the fallen leaves (Plate XIII. figs. 20, 21), and these are capable of a speedy germination, and the production of secondary reproductive bodies, as in the willow rust above alluded to (Plate XIII. fig. 24).

Probably, also, the similar rust on the poplar (Plate XIII. figs. 18, 19), or on the aspen, may be met with under like conditions; *i. e.*, the summer spores, which are yellow and spherical, on the living leaves, and the brown permanent masses of winter spores on the fallen and decaying leaves. The sole remaining British species is not uncommon on leaves of the common spurge in gardens; and whilst the yellow pulverulent spores occur on the upper, it will not be improbable that black permanent spots will be found on the lower leaves (Plate XIII. figs. 22, 23), inclosing closely-packed, rudimentary, elongated or wedge-shaped cellules of the winter spores.

In conclusion, I will offer a brief guide to the distinctive features of each of the several groups which have been noticed in the foregoing pages, for the assistance of those who may wish to pursue the study further than we have been permitted to carry them.

Spores of one order—

Simple and free.

Without appendages.

Inclosed in separate cells ..... *Uredo.*

Not inclosed ..... *Lecythea.*

With appendages.

Deciduous ..... *Trichobasis.*

Permanent..... *Uromyces.*

Concatenate.

Afterwards free ..... *Cystopus.*

Compound..... *Polycystis.*

Spores of two orders—

Cylindrical, septate ..... *Coleosporium.*

Wedge-shaped, compact ..... *Melampsora.*

EXPLANATION OF PLATE XII.

Fig. 1. Mercury Rust (*Uredo confluens*), on leaf of *Mercurialis perennis*.
„ 2. Spores of the same, magnified.
„ 3. Nightshade Rust (*Uredo Circææ*), on leaf of the enchanter's nightshade (*Circæa lutetiana*).
„ 4. Spores of the same, magnified.
„ 5. Twin-spot Rust (*Uredo bifrons*), on leaf of Sorrel (*Rumex acetosa*).
„ 6. Pustule of the same, enlarged.
„ 7. Spores, magnified.
„ 8. Corn Rust (*Trichobasis rubigo-vera*), on leaf of wheat.
„ 9. Portion enlarged, showing the pustules.
„ 10. Spores further magnified.
„ 11. Cluster of spores of *Trichobasis linearis*.
„ 12. Spores of the same, further magnified.
„ 13. Ragwort Rust (*Trichobasis Senecionis*), on leaf of *Senecio vulgaris*.
„ 14. Spores of the same, magnified.
„ 15. Thistle Rust (*Trichobasis suaveolens*), on leaf of *Cnicus arvensis*.
„ 16. Spermogone of Thistle Rust, magnified (*De Bary*).
„ 17. Spores of Thistle Rust, magnified.
„ 18. Rose Rust (*Uromyces ulmariæ*), on branchlets of dog-rose (*Rosa canina*).
„ 19. Spores of the same, magnified.
„ 20. Vetch Rust (*Uromyces appendiculata*), on leaf of *Vicia Cracca*.
„ 21. Appendiculate spores of the same, magnified.
„ 22. Pilewort Rust (*Uromyces ficariæ*), on leaf of pilewort (*Ranunculus ficaria*).
„ 23. Spores of the same, magnified.
„ 24. Cow-wheat Rust (*Coleosporium Rhinanthacearum*), on leaves of wood cow-wheat (*Melampyrum pratense*).
„ 25. Free spores from the same, magnified.
„ 26. Sow-thistle Rust (*Coleosporium sonchi-arvensis*), on portion of leaf of *Sonchus oleraceus*.
„ 27. Group of spores from the same, magnified (*De Bary*).
„ 28. Coltsfoot Rust (*Coleosporium Tussilaginis*), on portion of leaf of coltsfoot (*Tussilago Farfara*).
„ 29. Spores of the same, magnified.
„ 30. Group of spores, *in situ*, of *Coleosporium Rhinanthacearum* (Tulasne).
„ 31. Trefoil Rust (*Uromyces apiculosa*), on leaf of clover (*Trifolium repens*).
„ 32. Spores of the same, magnified.

PLATE XIII.

Fig. 1. Willow Rust (*Lecythea caprearum*), on leaf of sallow (*Salix caprea*).
„ 2. Spores of the same, magnified.
„ 3. Ringlet Rust (*Lecythea gyrosa*), on portion of leaflet of raspberry (*Rubus vitis-idæa*).

Fig. 4. Pustule of the same, enlarged.
„ 5. Spores, further magnified.
„ 6. Flax Rust (*Lecythea Lini*), on leaves of purging flax (*Linum catharticum*).
„ 7. Pustule of the same, enlarged.
„ 8. Spores, further magnified.
„ 9. Buttercup Smut (*Polycystis pompholygodes*), on leaf and petiole of creeping buttercup (*Ranunculus repens*).
„ 10. Spores of the same, magnified.
„ 11. Violet Smut (*Polycystis Violæ*), on leaf and petiole of sweet violet (*Viola odorata*).
„ 12. Spores of the same, magnified.
„ 13. Rye-leaf Smut (*Polycystis parallela*), on leaf of rye (*Secale cereale*).
„ 14. Spores of the same, magnified.
„ 15. White Rust (*Cystopus candidus*), on fragment of cabbage-leaf.
„ 16. White Rust (*Cystopus candidus*), on fruit of shepherd's-purse (*Capsella bursa-pastoris*).
„ 17. Spores of white rust, magnified.
„ 18. Poplar Rust (*Melampsora populina*), on portion of poplar leaf (*Populus nigra*).
„ 19. Spores of the same, magnified.
„ 20. Birch Rust (*Melampsora betulina*), on decaying leaf of the common birch (*Betula alba*).
„ 21. Spores of the same, magnified.
„ 22. Spurge Rust (*Melampsora Euphorbiæ*), on leaves of common spurge (*Euphorbia peplus*).
„ 23. Spores of the same, magnified.
„ 24. Group of spores of the Birch Rust (*Melampsora betulina*), in active germination (*Tulasne*).

ON PROPER CLOTHING.

BY EDWIN LANKESTER, M.D., F.R.S.

WHILST fresh air is essential to health, there can be no doubt that one of the disadvantages that follows its possession is exposure to cold. From the earliest periods of his history, man has had recourse to various expedients for the purpose of maintaining the warmth of his body. His house and his clothes are arrangements which he makes for protecting himself from cold. It follows, then, in a natural sequence, that when we have spoken of the importance of fresh air, we should proceed to speak of the necessity of maintaining the warmth of the body; and as clothing is one of the most natural ways of protecting the body from cold, we will now put together a few remarks on the matter of clothes. We shall take up here, the whole subject of Dress, and speak of its use and abuses.

Clothing is not only employed by man for warmth, but also for coolness—contradictory as that may be—for protection, and for ornament.

As, however, in this climate, dress is mostly worn for the sake of its warmth, we shall speak first of the reasons for this, and the kinds of dress which are most adapted for the purpose.

If we take a Fahrenheit's thermometer and place it in contact with any internal part of a human body, we shall find that it rises to the temperature of 98°. This temperature, which is called on the thermometer "blood-heat," is found to be constantly the same, whether the human being is living in temperate climes like our own, dwelling in the Arctic or Antarctic zones, or under the torrid sun of the tropics. Every animal with a perfect heart, as birds and mammals, has its own peculiar temperature, and each species maintains its own temperature, to whatever external temperature it may be exposed. Slow-moving animals, as the elephant, hippopotamus, and rhinoceros, have a lower temperature, whilst quick-moving animals, such as birds of rapid flight, have a much higher temperature than man.

The constancy of this temperature of animals shows clearly

that it originates independently of external circumstances. It is, in fact, produced by the combustion of food in the blood and tissues, in contact with the oxygen of the air which is taken in during respiration. If a sufficiency of food is taken, and there is due exposure to atmospheric air, the temperature of the human body is maintained at 98°. It may then be asked, where is the necessity of clothing to keep us warm? If man were a mere animal—if, like the beasts of the field, the only objects of his existence were a sufficiency of food and the propagation of his race, he could live without clothing. There are savage races of men all over the world, in both cold and temperate regions, who live but with little or no clothing. The moment, however, that man rests from the chase, that he begins to till the ground, and forms tastes connected with comfort and indulgence, then he discovers the necessity of protecting himself from that external cold which rapidly diminishes the temperature of his body, and which requires large supplies of food, as fuel to this internal fire, and active exercise, to enable the digestive organs to fit the fuel for burning. Just as man is active in his habits, and can digest abundance of food, is he independent of the necessity of clothing.

In proportion, however, as we find him devoting himself to commerce, and engaged in manufactures, do we find him building warm houses and putting on warm clothing. Clothes, in fact, act in two ways: they diminish the necessity of consuming large quantities of food, and prevent the tax upon the digestive organs which such large quantities of food would imply. Just in accordance to the external temperature is the demand made upon the system to keep up its temperature by supplies of food. Even with our artificial habits of clothing, the men who live in the coldest climates consume the largest quantity of food, and in this country we eat more in the winter than the summer. Nay more, we consume our own substance more in the winter than the summer, and weigh least in winter, and most in summer.

It is one of the great objects of civilized man to adapt himself to all external temperatures, so as to maintain his temperature at 98°. This he does by consulting his instincts and using his reason, and adapts his diet, his house, and his clothing, to this necessity of his life. He does it by his instincts vaguely and uncertainly, falling into errors which are constantly destructive of his health and life. One of the most universal of instincts of civilized man is to shut out the cold. He huddles himself with his fellows in cots and cabins, and the dens of civilized towns, to maintain his warmth and spare his food; but in doing this he contaminates the air

he breathes, and shuts out that oxygen which is more necessary to his life than even the warmth of his body. So terrible is the effect of atmospheric poison on his body, that when the cold comes, it finds more victims among the overcrowded homes of the poor than among any other class. Thus one week's continuous cold—the thermometer ranging from ten to twenty degrees below the freezing-point during the second week of January in this year—added nearly 2,000 victims above the average deaths of the season of the year to the mortality of London. This "wave of cold" was felt more acutely in that class of our metropolitan population whose systems are rendered less able to resist the influence of cold in attempts to secure warmth by the exclusion of fresh air.

The materials of clothing used by man are obtained from both the animal and vegetable kingdoms. Types of the substances obtained for clothing purposes from the vegetable kingdom are afforded in cotton and linen. Cotton is the hair of a plant, obtained from the inside of the fruit. By the accident of a twist during its growth it is possible to spin it into a thread, and it thus becomes the basis of our great cotton and muslin manufactures. The fibres of linen are the vascular tissue of the common flax, which, when prepared, are formed into threads, which are woven into the textile fabrics known as linen. These materials are bad conductors of heat. It is on this account that they are used for clothing purposes. Where the object of dress is to keep in warmth, those substances form the best articles of dress which conduct heat least. Another class of substances used for dress are the hairs and fibres of animals. The wool of the sheep, and the silk produced by the silkworm, are the substances most constantly woven into the articles of dress. Both wool and silk are worse conductors than cotton or linen. Hence we find that animal substances are preferred to vegetable substances, when the object is to keep in warmth.

It is, in fact, practically known that cotton and linen are cooler than cloth or silk: and whilst in this country we prefer the latter in winter, we have recourse to the former in summer. Men clothe themselves in winter with great coats of cloth, but they wear cotton and linen jackets in summer. In the winter, women clothe themselves with cloth mantles, but in the summer they put on their muslin, calico, and other light dresses. This is quite correct, and it should be recollected as a rule that cotton and linen garments are coolest, the linen being cooler than the cotton, and that woollen and silken garments are warmest.

The colour of our clothes is not altogether a matter of indifference. White and light-coloured clothes reflect the

heat, whilst black and dark-coloured clothes absorb the heat. Hence, in the summer it is clearly policy to wear white and light-coloured clothes, because they reflect the heat of the sun, and prevent its heating the body through the clothes. But what then with regard to winter clothing? It might be supposed that black is the right colour; but if we consider that this colour radiates heat, we shall see that a man in black loses his heat faster than if he were dressed in white. The fact is, white is the best colour both in summer and in winter; for it keeps off the heat in the summer, and retains the heat in the winter. This undoubtedly looks like blowing hot and cold, but it is nevertheless true. The coachman will tell you that his white duffel coat is warmer in winter and cooler in summer than any other kind of coat. The brewer's drayman will wear his white stockings all the year round, and tells you that any colour would be less agreeable to his feelings.

It will now be better understood how clothing can become a source of coolness. A black man exposed to the tropical sun will find that a white dress acts by protecting his body from the rays of the sun, whilst the white man will feel the advantage of a covering to reflect the same rays, rather than that his own skin should be used for the purpose. Hence in hot climates, clothes are worn to keep the body cool.

In many parts of the world, man is exposed to the attacks of the animal creation, especially insects, the bites of which are prevented by covering the body with some sort of textile fabric. The skin is also protected from the accumulation of dirt by the covering of the clothes. In our own climate, those parts of the body which are exposed to the air need constant washing, from the tendency of the dirty particles of the air to adhere to the skin. Certain parts of the body are also exposed to pressure, which it is found exceedingly desirable to prevent. This is especially the case with the soles of the feet, and man, at a very early period of his civilization, puts his feet into sandals, or clothes his foot with boots or shoes.

Whilst clothes are thus worn for utility, no one can look upon clothed man without seeing that he has not put his clothes upon his back merely with a utilitarian object in view. Look at that Indian squaw; see how she has ornamented the single garment which she wears. Look at her husband with a simple dress, and yet he has stuck peacocks' feathers into his head-dress, and glass beads in rows on his neck to ornament his form. Pass on, step by step, through the various grades of civilization, and you see that both in form

and colour, dress is made subservient to the great idea of decorating and beautifying the person.

This decoration is principally seen in colour and form. Nor let any one for a moment condemn this natural tendency to adornment. Deep in the instincts of our nature is laid the admiration of colour, and to meet this feeling, the Creator adorns his creation with all the tints of the rainbow. In the dark unfathomed caves of ocean, a thousand forms of coloured beauties meet the eye, unnumbered insects expand their wings, coloured with varied tints, whilst birds and flowers vie with each other in presenting the primitive colours of the rainbow in all their possible tints to meet the eye of man. Surely then, if God has adorned so brilliantly His lower creatures, it is left for those who have the power of imitating their Creator, to deck themselves in a similar manner. This subject should have much further study and development than it has hitherto received. There is a harmony of colours as of sounds, and there is a discord of colours as of sounds. It is this discord of colours that often makes dress so offensive, and which disguises the form and grace which naturally belong to man.

It is by this natural taste for ornamentation in dress that the arts of the dyer and calico-printer have been called into existence, and to which we owe the more extensive use of bright colours, now so often seen in red petticoats, stockings, and other brightly-coloured articles of dress. The desire for rich and varied colours in clothing has given an impetus to those chemical researches which have resulted in the discovery of the glowing tints of Magenta, Mauve, and Solferino. The taste for ornamental dress has given many branches to our industry, and is an example of those pure and simple tastes of the human mind, by which it is led on to cultivate an admiration for the beautiful colours of nature, and in its highest tendencies to admire and imitate the work of the landscape-painter.

The form of dress has also been a worthy object of study. Not that modern men or women either have succeeded in this respect. But certainly to the other sex must be given a greater appreciation of beauty in the form of dress. Even the utmost departure from the ordinary conventional rules of dress which female attire has recently taken, in the diminutive size of the bonnet and the inordinate extension of the skirts, can be defended on the ground of their having some shade of artistic merit. Even the chisel of a Phidias might not have despised the graceful folds of the flowing skirts of a modern belle. But when we turn to male attire — whether as a soldier, a sailor, an aristocrat, or a plebeian, there is scarcely

a curve or a line that can be said to be beautiful. An ancient sculptor would have avoided it with horror; and if the angels are allowed to look down upon the earth, and have their feelings kindled by its beauty, there must be one object amidst its charms that must excite in their minds mingled feelings of disgust and pity at its ugliness, and that is the clothed civilized man of the nineteenth century.

Having said thus much of the use of dress, let us proceed to speak of its abuses. First, then, as all articles of dress must be attached to the body in some way or other, we will speak of the dangers of their attachment under the head of *undue compression*. We begin at the head, and this leads us to speak of hats, caps, and bonnets. Why wear them at all? Of all parts of the body, the head seems least to need clothing. A most beautiful, warm, and natural covering has been created upon the head, and why it should be covered by hats, caps, and bonnets nobody has any very definite notion. It seems, however, in hot countries that head-coverings prevent the too powerful rays of the sun striking upon the head, and thus producing a *coup de soleil* or some minor inconvenience. In wet climates, too, like our own, it is uncomfortable to have wet hair. So for one cause or another modern man and woman have got into the habit of wearing some kind of head-gear. That modern man may discover one day that it is unnecessary is not at all improbable. Some thirty years ago, he invariably placed a heavy cap upon his new-born babes, but recently he has found that his innocents do better without them. It is not then I say altogether beyond the bounds of probability that he may see fit to get rid of his own head-dress. In fact, the women a few years ago did nearly get rid of this article of dress, and I never heard that they suffered from it. But I am now to speak of the danger of compressing the head from the weight or fitting on of this article of dress. Children and women seem to be in little danger in this respect. The caps of children are light and fit loosely on their heads; so of women's bonnets. This cannot be said of the hats of men. The hat is a melancholy instance of the utter inability of man to throw off the shackles of custom. The modern chimney-pot hat, with its small brim, is about as ridiculous and unsuitable an article of dress as could possibly be devised. Who could for a moment see it on the head of a Greek Apollo, Mercury, Cupid, or Hercules, without roaring with laughter? Who that wears it does not feel its inconvenience? Its weight necessarily compresses the head; and in order that it may resist the currents of our atmosphere, it is always pushed down upon the head in such a way as to produce a dangerous compression of the

blood-vessels of the scalp, and may lead to headaches, giddiness, and even more serious results. The head-dress of our soldiers is even more objectionable still. The shako frequently weighs from ten to fifteen ounces, whilst the bear-skin hat reaches a weight of between two and three pounds. Such head-gear can perhaps be borne by courageous men, even under the influence of a July sun in this climate, but it becomes insupportable in hot climates, especially when long marches have to be made.

A recent physiological writer attributes the more frequent baldness among men as compared with women, to the heat and compression of the hats that are usually worn. If no other form can be devised, and they must be made of the unyielding materials employed for their manufacture, they should at least be made as light as possible, and instead of black they should be white. In hats, as well as in body-clothes, white has the advantage of keeping off the heat in summer, and keeping in the heat in winter.

From the head I pass to the neck. If any one will attentively consider the structure of the human body, he will see that the great veins which carry the blood from the interior of the head are placed not very low down in the neck, and are easily compressed from the outside. Such compression congests the brain, and may produce even effusion on the brain. The necks of children are not often compressed by collars or other articles of dress, and women generally dress their necks with great freedom from constraint. It is amongst men that the ridiculous and entirely unnecessary custom of clothing the neck has come to be, through fashion, a source of serious mischief by compressing the great veins of the neck. The habit of fastening the collar tight round the throat, and of covering this with a neckcloth or stock, is almost universal amongst European and Anglo-American men. It has been adopted by the armies of Europe, and has nowhere been carried to greater excess than in the English army. One object of this arrangement is undoubtedly to keep the head up, and this has the advantage of throwing up the chest so as to keep the whole body upright over the great centre of support, the pelvis. It is however quite worthy of consideration as to whether this object could not be much better obtained by proper drill, than by an arrangement which endangers the circulation in the brain, and may be productive of dangerous disease. With whatever impunity such strangulation may be borne by the young and the vigorous, there can be no question as to its disastrous results amongst the feeble and the aged, in whom the walls of the blood-vessels of the brain are necessarily weakened, and which at any time may give way from

any obstruction to the free return of their contents to the heart.

From the head and neck we may pass to the body. One of the great objects of clothing is to keep the body, independent of the head and extremities, warm. Hence the great bulk of all kinds of garments are attached to the body by belts, braces, stays, bandages, and other devices. We need hardly refer here to the now exploded practice of swaddling children in innumerable folds of bandages. This practice is now pursued amongst barbarous races, but the evils attendant upon it are generally perceived amongst intelligent communities. It still, however, occasionally happens that the clothes of an infant are so tightly placed round its body, as seriously to interfere with the proper functions of the lungs, and lead to diseases which end in death.

The active occupations of men have led them very generally to dispense with body-clothing that seriously interferes with the muscles of respiration, and the functions of the abdominal viscera. Those men who are not beyond the reach of the caprices of fashion, have sometimes adopted a dress which has involved a very grave departure from that freedom of movement of the muscles of the body which is essential to health.

It is, however, in the other sex that a style of dress has been adopted which is open to the strongest possible condemnation, from its dangerous compression of the body. The loose robes of the women of antiquity have been exchanged for the bandages and corsets of modern dress. This system has resulted in the adoption of articles of dress, which not only compress the blood-vessels of the body, producing congestion, but restrain the action of those muscles which are essential to the proper movement of the whole body, and the due performance of the functions of respiration. A further evil has been demonstrated, in the fact that these articles of dress being worn by growing girls, the skeleton of the body has been actually distorted by the artificial pressure, and personal deformity has been the result. This has not been an exceptional result; whole classes of our countrywomen have laboured under this deformity, and the only class amongst them in which the thorax has been allowed free development is that which, performing the labour of men, have found out that an artificial method of dressing is incompatible with their work. The reign of fashion has perhaps recently relaxed in some measure in this respect; but the idea of woman as to what should constitute the central portion of her dress, must be revolutionized before we can expect this dangerous and deforming system of dress to be abolished. There ought to be no tampering with it, and a new idea of comeliness in female dress must be substituted, if

we would get rid of the evils which result from the present fashion of compressing the bust with stays or corsets.

Every writer on Hygiene has unequivocally condemned this absurd custom, and there is no practitioner of medicine but has witnessed the destructive influence that the corset has on health. The compression produced by it diminishes the action of the lungs, and leads to those deposits which fatally destroy life in consumption, whilst the diminished activity and action of the body engendered, lays the foundation of those dyspeptic and nervous diseases to which the great mass of our middle and upper class females are liable.

What is true of the head, neck, and body, is also true of the extremities. Any article of dress so fastened as to prevent a free return of the blood to the heart, congests the vessels below the part compressed. Bracelets, armlets, wristbands, and garters, may all be so worn as to produce painful affections of the limbs compressed.

There is no member of the extremities which has been more disgracefully used than the foot. This wonderful organ, by the perfection of which God has "made man upright," and whose structure so pre-eminently distinguishes him from his recently so called "great-grandfather," the Gorilla, has been made to suffer from compression more generally than any other organ. The thought at once suggests the cruel practice of the Chinese, who prevent the growth of the female foot, by placing it in infancy in an unyielding shoe. This fact has had the universal testimony of travellers, in China, and if anything more was wanted to prove it, a collection of the feet of Chinese women is at present to be seen in the Museum of the College of Surgeons of England, in which, by the careful dissections of Mr. Flower, the Curator, the sad havoc to natural growth produced by this heartless custom is scientifically demonstrated.

The great object of the shoe is to protect the sole of the foot from the injury it is likely to sustain by the weight of the body pressing it against the irregularity of the surface of the earth. The sole of the shoe is therefore its chief use. It is, however, necessary to use some kind of strap or bandage to keep the sole upon the foot. The simplest form of foot dress in which this object is secured is the sandal, worn by the less-civilized nations of the earth, as well as the more ancient. It is found, however, that other objects may be accomplished by aid of the pressure necessary for keeping the sole on the foot, and coverings for the foot and leg have been attached to the sole; hence the modern boot and shoe. Hence also the suffering of the modern foot. The form of the boot and shoe has proved no exception to that love of the grotesque, which

has compelled mankind in all ages to submit to the sufferings inflicted by fashion. Boots and shoes have been made of every form almost, save that of the human foot, and the consequence has been the production of painful diseases on the surface of the foot, and a distortion of its bones and muscles. This is not a mere assertion. Let any one take a model of the feet of the beautiful Grecian statues, and compare it with the model of a living foot—the foot of the Medicean Venus for instance, with that of a modern belle, or the foot of Hercules with that of one of our labourers or soldiers. It will at once be seen how terribly our unthinking and unnatural way of dressing the foot has worked against its primitive beauty and strength. That a shoe made of leather should fit the foot, would seem a proposition to which every one would assent, yet the assertion may be safely made, that not one shoe out of ten thousand made by modern shoemakers fits the foot at all. By dint of custom, like the Chinese women, we manage to submit, without complaining, to the vulgar caricatures of the form of the foot, which characterize our modern boots and shoes.

Nor is this compression, which produces corns and bunions, chilblains, ulcerations between the toes, and loss of the nails, the only fault to be found with modern shoes. The Creator has made this part of the human sole flat, but the shoemaker has discovered that the foot of the gorilla and chimpanzee, which compels them to walk on their toes, is more elegant. They accordingly exalt the heel by an extra piece of leather on the sole, and thus give to the human figure a monkey-like gait. If our young women knew how they are distorting their appearance by this practice, surely they would give up wearing high-heeled boots.*

But we must leave the subject of compression to say a few words on other abuses of dress. Fashion and indolence have brought on an evil which ought to be avoided, and this is the insufficient clothing of young females and children. The fashion of exposing the neck and shoulders in women has undoubtedly led to serious evils. The cooling down of the whole body thus produced is more than the circulating system can bear, and congestion of the lungs and the great vascular organs in the interior of the body is the result. It is too often the case that this system of dressing engenders a susceptibility to slight draughts, which, being prevented, more serious

* Those who do not consider the health and comfort of their bodies as too insignificant for attention, will do well to consult on this subject, Mr. Humphreys' book on the "Structure of the Foot and Hand," and Mr. Dowie's book on the "Foot and its Coverings."

mischiefs than any which lead to the access of fresh air are produced. It is in such cases as this that we see the folly of attempting to remedy one set of evils without knowing what may follow from another. Fresh air, however necessary to life, is death to those who are clothed insufficiently. This should be especially recollected with regard to little children, whose tender frames are far less able to endure cold than those of grown-up persons. Yet they are excluded from fresh air, and the greatest carelessness is displayed in dressing them. Directly a baby leaves off its long clothes it is in danger of being underclothed. This danger is increased when it can run alone, and it is exposed to the outside air, with an amount of destitution of garments for its lower extremities, which, if it occurred in grown-up persons, would at once suggest the necessity of further clothing for the sake of warmth. If the idea, then, can once be comprehended that children of tender years are more susceptible of cold than grown-up persons, a very different kind of dressing would take place, and a holocaust of victims at the shrine of inflammation of the lungs would be saved.

I need hardly enter here upon the importance of changing and cleaning clothes. At the same time, this is a subject that demands more attention than it has yet received. The habit of wearing dark-coloured clothes instead of light-coloured ones, has its origin in economical considerations, and it would be well to consider whether an amount of dirt is not thus tolerated, which may go far to the spread and production of disease. Dark-coloured clothes after they are worn a little time become dirty, and are as objectionable as light-coloured clothes under the same circumstances, although the dirt cannot be seen.

But I must leave all other abuses of dress, to consider evils of a wider extent. To heap more clothes on the back than is necessary, is a great evil in both sexes. One of the dangers of too much dress is that, unless it is adjusted so as to press equally and bear directly upon the pelvis—the chief centre of support of the body—it is likely to produce deformity. Heavy coats, shirts, or body dresses of any kind, may have their weight thrown too much before or behind, or on one side, and produce deformity. The evil is one to which man is much less exposed than woman. To obtain an ample surface on which to display the beautiful fabrics of cotton and of silk, which have been expressly manufactured for her in patterns of the most wonderful variety and in colours of surpassing beauty and harmony, she has submitted to an enlargement of the skirts of her dress, which, by its weight, endangers the symmetry of her frame; and by its extending beyond the reach of her control, runs the risk of perils which exposes her

to the most horrible of deaths. This fashion of extended skirts has come in and gone out, from mere caprice. Our grandmothers wore hoops, and our mothers laughed at their folly; but our sisters, wives, and daughters have revived the folly, with results more melancholy than any connected with the previous exhibitions of this fashion.

I have not alluded in this paper to the *inconveniences* of dress, and I shall not, therefore, consider the present fashion of female dress on this ground. That our rooms have grown less—that our freedom of intercourse in the drawing-room is interrupted — that our vehicles are encumbered — that our places of worship will hold fewer—that our sick-rooms are unnecessarily swept, and our shins injured by steel hoops,— are grievances that no one would think of referring to; but when the question is one of life and death, then it seems necessary that the subject should be discussed. Are we justified in submitting to any fashion, which can be proved annually to sacrifice several hundreds of victims in our own country alone?

I will state a few facts. In one year — from the 1st of August, 1862, to the 31st of July, 1863—forty-eight inquests were held on persons burned to death, in the central district of Middlesex, comprising nearly a million of people. Of these, thirteen were males, and thirty-five were females. Of the males, eight were under five years of age; and of the females, nine were under that age. Of the whole, thirty-one were above five years of age. Now mark the influence of dress. Of the thirty-one who were burned over five years of age, there were three boys and two men; but there were eight girls and eighteen women. Above a third of the whole were women above twenty years of age. But the deaths from burning in this district of London are actually below the average deaths from this cause in the whole community; and the Registrar-general's returns present us with the frightful fact, that eight persons are burned to death every day in England and Wales, and of these, above one-eighth are grown-up women.

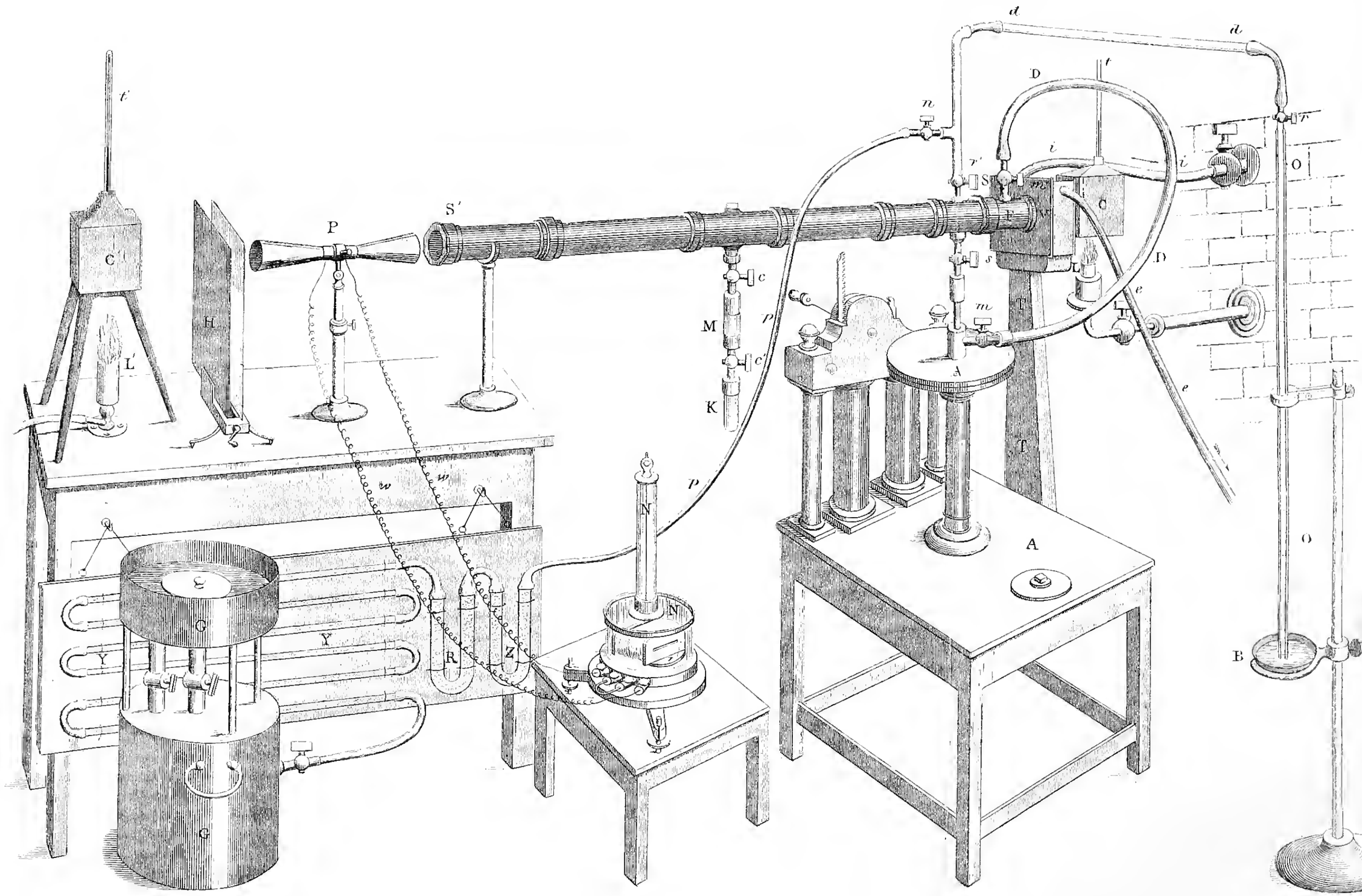
I cannot here give any facts to show whether the health of women has been improved by the introduction of the recent fashion of wearing extended dresses, but it is a most notorious fact that the more extended the dress the more likely it is to catch fire. Not only do I think it worthy the consideration of women how far they can divest themselves of the extent of skirt which endangers their lives, but I think it a question deserving their utmost consideration as to whether their dress is not altogether unfitted for a climate, where fires, and gas-lamps, and candles, are the necessary adjuncts of our civilization. It is all very well to talk sentiment about what is becoming to women, or to make fun of those who wish to

reform their dress; but it is a question in morals, as to whether we ought to support, on the ground of fashion, a mode of dressing which, in this country alone, immolates, every five years as large a number of women as perished in the heart-rending catastrophe of Santiago.

It should, however, be remembered that extent of dress alone is not the only cause of these accidents. The nature of the materials of which women's dresses are composed is greatly conducive to the production of accidents by fire. Cotton and linen are eminently combustible materials, and as long as the boy is dressed in his Holland pinafore and his calico frock he is as much in danger of being burnt as his little sister. But directly he gets into breeches his chances of being burned diminish, as much on account of the form as the nature of the material he wears.

If it must be denied to our girls and women to wear either the form or the material of the dress of boys, there is one thing left that we can do. Chemistry has put into our possession a variety of compounds, soluble in water, which if applied to linen and cotton will render them flame-proof, if not uninflammable. Such compounds are, tungstate of soda, sulphate of ammonia, sulphate of zinc, sal-ammoniac, alum, and common salt. Any of these substances may be put into the starch with which cotton and linen goods are got up after they are manufactured and washed. Starches have been patented with these substances in them, and druggists sell the salts, with directions for use; but up to the present moment little or no effect has been produced. Every now and then the newspapers startle the community with the fact that another mother of a family has been burned by crinoline. Society duly observes, regrets, and forgets the circumstance. Some effect might perhaps be made if each daily newspaper could record, as it occurred, the deaths of the women that die every day victims to burning. If the children and men were added to this portion of the eight who die, it might increase the anxiety of society on the point. But it should be recollected that there must be added to this the sufferings of those who do not die. Where *one* burned person dies, *ten* get well, amid the greatest suffering and the most acute of agonies. Are not these sufferings, and this death, worthy of an effort to save?

I must now, however, leave the whole subject of dress to the consideration of thoughtful persons. I have been prompted to make these remarks in the hope that I may assist any who may seriously think it worth their while to make an effort to rescue the art of dressing from the domain of Fashion, and place it under the laws and direction of Reason.



Absorption and Radiation of Heat by Gases and Vapours.
(From Transactions of the Royal Society.)

J. Basire Sc.

157

ON THE ABSORPTION AND RADIATION OF HEAT.

BY H. DEBUS, Ph.D., F.R.S.

OUR knowledge of heat has received during the last few years considerable additions through the researches of Professor Tyndall, of the Royal Institution. The results of his investigations not only explain some of the grand operations of nature, but also allow the philosopher a more correct estimation of molecular actions. The following contains a short account of Mr. Tyndall's researches and results, and of the theoretical views by means of which the latter may be explained. Till very lately the majority of philosophers supposed heat to be an invisible substance, without weight, endowed with great elastic force, and corresponding tendency to expand. It was thought to surround the atoms of bodies like an atmosphere, and to fill the spaces between their molecules. On account of the simple explanations which this theory afforded of most of the phenomena of heat, it was able to maintain its position in the domain of science, even after the discovery of facts for which it was not able to account. Such facts are the production of heat by friction and percussion, and the conversion of heat into mechanical force.

Count Rumford was struck by the great amount of heat developed by the boring of cannon, in one case sufficient to boil 18¾ lb. of water, and Davy transformed ice into water by rubbing two pieces of ice together. In each case a very great quantity of heat was developed, and the question may be asked, "whence did the heat come?"

Locke says, "Heat is a very brisk agitation of the insensible parts of the object, which produce in us that sensation from whence we denominate the object hot: so what in our sensation is heat, in the object is nothing but motion." Bacon and Davy held similar views. The theory of heat now adopted by the most distinguished scientific authorities, considers heat to be a mode of motion of the infinitely small particles, called atoms or molecules, of which bodies are composed, the conduction of heat being the propagation of this motion from one part of the body to another. If we feel the

sensation of heat, the motions of the particles of the hot body are imparted to our nerves, and by friction the particles of bodies are caused to assume that peculiar motion which announces itself to our senses as heat.

It is, however, well known that heat may pass through a vacuum, and that the sun's rays pass, on their way to our globe, through immense spaces considered void of matter. How is heat, according to the dynamical theory, transmitted through a vacuum? In order to account for such transmission, the whole of the universe and the pores of all bodies are supposed to be filled with a medium of extreme tenuity and almost infinite elasticity, called ether. A sounding bell causes the elastic air to vibrate, and when the vibrations reach our ears we obtain the sensation of sound. In an analogous manner, a hot substance induces vibrations in the ether, which spread in all directions with immense velocity along straight lines, until their progress is stopped or their direction changed by some obstacle in their path. This sort of motion, called radiant heat, may take place in a vacuum, because the ether is supposed to be everywhere present. If the heat-waves strike against a substance placed in their way, their motion is imparted to the atoms of the body, and thus the temperature of the substance is raised, or they are reflected, or they are allowed to pass through the substance. The reflection, absorption, and transmission of radiant heat in solid and liquid bodies has been examined by the illustrious Melloni; he also attempted to ascertain by experiment if gases do absorb sensible quantities of radiant heat. Rays, allowed to pass through a column of air 18 feet long, did not exhibit any diminution in their intensity. On the other hand, Dr. Franz, of Berlin, found that air contained in a tube three feet long absorbed about 3·5 per cent. of the heat radiated from an Argand lamp. Both results are incorrect; Melloni's apparatus was not sensitive enough, and Franz's arrangement gave results which were not at all due to absorption.

Except one experiment, by Sir H. Davy, these are, we believe, the only attempts made to measure directly the transmission and absorption of heat by gases. If gases absorb heat at all, more decided and valuable results may be expected from their examination than either from solids or liquids. In gases we have not to contend with disturbing influences, such as the force of cohesion, and therefore the laws which govern radiation and absorption will reveal themselves in more simple forms. Also the influence of our atmosphere on solar and terrestrial radiation would become known in such an inquiry.

The most obvious way to determine experimentally the

transmission of radiant heat through gases, would be to pass heat from a constant source through an exhausted vessel, and to determine the amount transmitted; to fill then the vessel with the gas or vapour to be examined, and determine, whilst the vessel is still exposed to the same source of heat, the transmitted heat again. The difference between both results would express the heat absorbed by the gas. This method is not sufficiently sensitive in the case of air and some other gases. Mr. Tyndall therefore had recourse to a most ingenious process, which will be best understood from the following description.

The instrument used for measuring the heat was the well-known thermo-pile of Seebeck and Melloni. It consists of a bundle of bars of bismuth and antimony, the single bars separated from each other by gypsum or some other non-conductor of electricity, but soldered together alternately at their ends. The two end-pieces of this so-called pile are connected with the copper wire of a galvanometer. Rays of heat impinging on one of the faces of the thermo-pile, develop in the latter an electric current, which during its passage through the copper wire deflects the magnetic needle of the galvanometer. An increase of the heat would augment the deflection of the needle. If we suppose our source of heat and its distance from the pile so chosen, that the radiant heat after passing through an exhausted tube would cause a deflection of 10° of the needle, then admission of an absorbing gas would cut off some of the rays of heat, and the needle would recede to a proportionate extent. We will assume the needle to point to $9\frac{9}{10}^{\circ}$ after admission of air. A difference of $\frac{1}{10}^{\circ}$ could scarcely be appreciated, and would therefore be a very doubtful result. The absolute amount of heat to cause the needle to move through an arc of 10° is very small. A more powerful flux of heat would increase the deflection and also the absorption. If we suppose the needle to have been deflected 81° by radiant heat passing through an exhausted tube, an absorption of 1 per cent. of this amount could scarcely be detected by a retrograde movement of the needle, for it requires much more heat to move the needle from 80° to 81°, than from 9° to 10°; the galvanometer is more sensitive when the needle is near zero. Hence, if the instrument could be kept in this sensitive condition, whilst the substances to be examined are exposed to a very powerful flux of heat, the attending absorption might be detected.

If the needle of the galvanometer is in its normal position, heat, which falls on one side of the thermo-pile, will always cause a deflection in the same direction; but if the heat is allowed to meet the opposite face of the pile, a deflection opposite in

direction to the former will result. Therefore, if equal quantities of heat fall simultaneously on both sides of the pile, the effect produced by the one source will be counterbalanced by the equal effect of the other source, and the needle will remain at zero.

Let SS' represent a glass tube 2′ 9″ long and 2·4 inches in diameter; the ends of this glass tube closed air-tight by plates of rock salt, in order that the tube may be used empty or filled with the gas to be examined. By means of air-pump AA, through the opened stop-cock S, SS' can be exhausted, and the gas to be examined admitted into experimental tube SS' through the flexible tube $p\,n$. NN is the galvanometer, P the thermo-pile, and C' a cube filled with hot water. Moving carefully screen H by means of a screw, such an amount of heat may be allowed to impinge from cube C' against the pile P, as to counterbalance the effect produced by the heat passing through the exhausted experimental tube SS' and striking against the opposite face of the thermo-pile. Now, if a gas be admitted through $n\,p$, a portion of the heat passing through $S\,S'$ will be absorbed, unequal amounts of heat will fall on the two sides of the pile, and the source C' will preponderate. Accordingly, a deflection in this sense takes place, and the degree of deflection indicates the amount of absorption by the gas in SS'. The heat is supplied to SS' in the following manner. C is a cube with boiling water, or as in most experiments, a copper hood kept at the constant temperature of about 270° C and united by bracing with tube F, eight inches long, which in its turn is joined air-tight to SS'. During the experiments, chamber F is kept exhausted, and in order to prevent conduction of heat from C to SS', F is surrounded by a chamber through which a continual current of cold water is passing. $O\,O$, which is graduated and filled with mercury, communicates through $d\,d$ with tube $S\,S'$; it serves to determine the tension of the gas to be examined in $S\,S'$. Y, R, Z, are tubes used in purifying and drying the gases. Pure air, oxygen, hydrogen, nitrogen, admitted respectively into SS', caused a deflection of the needle of 1°. The total amount of heat, passed through the exhausted experimental tube, deflected the needle of the galvanometer 71° 5; if the amount of heat necessary to move the needle from zero to 1° be taken as a unit, the above 71° 5 deflection corresponds to 308 units. Hence, the absorption exercised by the gases mentioned amounts to 0·33 per cent. of the entire heat presented to them. Very striking results were obtained with olefiant gas. Of 360 units of heat transmitted through the exhausted experimental tube, 290, or more than seven-ninths, were absorbed after the admission of olefiant gas. This result entirely removes the

notion hitherto held, that gases are almost perfectly diathermanous (transparent for heat).

We find ammonia even a more powerful absorber than olefiant gas, indeed, it is almost black to rays of heat emanating from a source of low temperature. When the gas was in the tube, the interposition of a double metallic screen between the pile and source augmented the deflection very slightly.

In all experiments hitherto mentioned, gas at the tension of one atmosphere was employed. At lower tensions, the absorption becomes less, but the results obtained with different gases are still more striking than those arrived at under ordinary pressure. One, two, or more measures of olefiant gas were allowed to diffuse through the experimental tube SS', and the consequent deflections of the needle observed.

By this means we arrive at the result that at low tensions the absorptions are proportional to the quantity of gas admitted into the experimental tube. One measure of olefiant gas absorbs a quantity of heat expressed by the number 2·2 and 10 measures of gas $2{\cdot}2 \times 10 = 22$ of heat. The same rule holds good for other gases; but this proportion does not obtain when large quantities are employed.

Hence, the absorptions are only proportional to the quantity of the gas when small quantities are employed.

If we assume oxygen, nitrogen, air, and hydrogen to absorb at one-inch tension one-thirtieth of the quantity of radiant heat which they do absorb at 30-inch tension, an assumption which cannot be far from the truth, and take the amount of heat absorbed by air at one-inch tension as unity, we obtain the extraordinary result, that for tensions of one inch of mercury the absorption of ammonia is over seven thousand times, the absorption of olefiant gas seven thousand nine hundred and fifty times, whilst the action of sulphurous acid is eight thousand eight hundred times that of air.

Melloni found in the case of solids and liquids, that transparency for light and transmission of heat are independent of each other. Dark brown chloride of sulphur transmitted 63 per cent., and colourless transparent water only 11 per cent. of radiant heat from the same source. Professor Tyndall observed analogous comportment in gases. Hydrobromic acid is transparent and colourless like air, bromine vapour of a dark brown colour, yet the former absorbs nearly eight times as much heat as the latter.

The elements are all bad absorbers, whereas the superior absorbers are all compound bodies. In general, it may be said that, everything else remaining the same, the absorbing energy of a molecule increases when its structure becomes more complicated. Thus carbonic acid is a better absorber

than carbonic oxide, nitrous oxide (N_2O) a better absorber than nitric oxide (NO), and ammonia (NH_3) superior to either. This circumstance may be beautifully observed in the case of nitric oxide. The gas is quite colourless and transparent like air, but, as soon as it comes in contact with oxygen, both combine, and form pernitric oxide, a gas of a deep brown colour.

$$\underbrace{NO}_{\text{Nitric oxide.}} + \underbrace{O}_{\text{Oxygen.}} = \underbrace{NO_2}_{\text{Pernitric oxide.}}$$

Pure nitric oxide caused an absorption expressed by the number 1590, but as soon as air or oxygen was admitted to it, the effect or radiant heat was increased more than twenty-fold. Pernitric oxide is nearly of the colour of bromine vapour; but, notwithstanding this, the nitrogen compound possesses perhaps more than a hundred times the absorbing energy of bromine for radiant heat.

Results similar to the above were obtained with ozone. Pure oxygen, made in the ordinary way, deflects, as will be remembered, the needle one degree. Electrolytic oxygen (obtained by decomposing water with a galvanic current) gave Mr. Tyndall deflections ranging from 20° to 136°, according to the conditions observed in the preparation of the oxygen gas. If the plates which conducted the current into the water were of small size, an oxygen was obtained which gave greater deflections than was the case when larger plates were used; also a more energetic oxygen was developed when the temperature of the decomposing liquid was kept near the freezing-point. Oxygen which escaped from a decomposing cell, surrounded by salt and ice, gave an absorption of 136. Now, it is known that electrolytic oxygen contains variable quantities of ozone—in all cases, probably, much less than one per cent. Those specimens, which, according to the mode of their preparation, ought to have been rich in ozone, also proved the best absorbers of radiant heat. If, on the other hand, the ozone was removed from the oxygen, then the latter lost most of its absorbing energy, and sunk down to the level of pure oxygen.

It has been remarked that compound bodies are far superior to the elements as absorbers of radiant heat: hence Professor Tyndall concludes, if ozone be a modified oxygen, two or more atoms of ordinary oxygen must have collapsed and formed a compound group or molecule. If so, ozone ought to occupy less space than oxygen. These conclusions of Professor Tyndall are in harmony with the investigations of Andrews and Tait, and of the more recent ones of Von Babo. Oxygen may be converted, under the influence of electricity

of great tension, into ozone; and the latter, at a red heat, may be reconverted into oxygen. Von Babo showed that oxygen contracts when partially transformed into ozone, and assumes its original volume as soon as the ozone is reconverted into oxygen.

In order to get a clearer insight into the action of different bodies on radiant heat, we must for a moment consider the heat vibrations of the ether. If radiant heat is absorbed by a substance, the vibratory motion of the ether is transferred to the molecules of the body, ceases to exist as radiant heat, and the absorbing substance becomes heated. Vibrations of the ether which are transmitted through a substance pass the atoms or molecules of the latter without opposition. A good absorber, therefore, has a special aptitude to receive motion from the vibrating ether, which aptitude depends on the chemical and physical nature of the absorbing body.

Elements like oxygen, hydrogen, nitrogen, and bromine are not so good absorbers as their compounds. If we imagine elements to consist of single atoms, compound bodies would be formed by the union of two or more atoms into one group or molecule,—hydrochloric acid of an atom of chlorine and hydrogen, water of two atoms of hydrogen and one of oxygen, ammonia of three atoms of hydrogen and one of nitrogen. A compound like ammonia, composed of four atoms, would present to the vibrating ether a greater surface, and therewith more resistance, than a single atom like chlorine; hence, the latter would receive less motion from the vibrating ether, or, in other words, would be a worse absorber of radiant heat than the compound ammonia. Similar considerations would apply to other elements and compounds. Another influence, of a physical nature, must be coupled with this explanation of the difference in absorbing energy exhibited by various bodies. Vibrations are periodical motions, like the swinging to and fro of a pendulum. The time of one vibration is the time consumed whilst one movement to and fro takes place. The periods of a pendulum may vary according to the length of the pendulum; also the vibrations of the ether are of different periods, longer or shorter, according to the nature of the body which is their cause. The atoms of substances, be they solids, liquids, or gases, cannot under given conditions vibrate in all possible periods, but each substance has a preference for certain periods, and will be the best absorber of such radiant heat which consists of vibrations of those periods. The rays of one source of heat would be most abundantly absorbed by a substance, the molecules of which vibrate in periods coincident with those of the source of heat.

(To be concluded in No. XII.)

BOTANICAL EXERCISES.

BY THE REV. G. HENSLOW, M.A., F.L.S.

UNDER the impression that whatever may tend to popularize the various branches of Natural Science will not be unacceptable to our readers, we venture to offer, for the benefit of beginners, a series of floral exercises, as an assistance to self-instruction in the study of structural botany. And if any be already botanists, and are desirous of extending a love of this science amongst their friends or pupils, the following description of the use of the "Floral Schedule," we doubt not, will be found advantageous.

Just as a knowledge of arithmetic can only be acquired by working out numerous examples; of geometry or logic, by the study of problems; so it will be found, by adopting the method here proposed, that a knowledge of structural botany will be gained far more rapidly, and, we can assure our readers, with far more *amusement* than any prolonged study of books or flowers alone is capable of affording.

We will now at once proceed to describe and explain how to use the Floral Schedule.*

It consists of a blank form, containing seven columns divided into spaces, and having the names of the floral "whorls" arranged in the first, on the left-hand side, as shown in the accompanying diagram.

Flower.	No.
Pistil, *carpels*	
Stamen Filament Anther	
Corolla, *petals* Calyx, *sepals*	
Perianth, *leaves*	

The second column is headed No., and in the spaces beneath are to be inserted the actual number of parts in each whorl, ascertained by inspection and analogy jointly. For example, suppose we take a Wall-flower. Removing each sepal of the calyx, the number will be observed to be four, so that 4 must be written opposite the words

* The Floral Schedule was invented by the late Professor Henslow, and extensively used by him, with the most satisfactory results, both in his lecture-room at Cambridge and in his own village-school at Hitcham, Suffolk. Already many teachers have adopted it, and all testify to the great utility of its introduction, wherever a knowledge of structural and systematic botany is desired. A more elaborate paper on School Botany will be found in the "Museum," vol. iii. p. 43. Also a brief description of the Professor's method of teaching botany in his village-school, in the "Leisure Hour," No. 565.

"calyx, *sepals*." Similarly for the petals. The stamens will be found six in number, and the carpels two, so that these numbers must be inserted accordingly, and the first column of the Schedule will now stand thus:—

Flower.	No.
Pistil, *carpels*	2
Stamen Filament Anther	6
Corolla, *petals*	4
Calyx, *sepals*	4

The third column is headed "Cohesion." This word refers to the condition which is sometimes presented by the parts of the whorls being united; as *e. g.* in the Primrose, where the five sepals are combined into one piece (cohere), as also are the petals of the corolla. The words used to express this condition are *gamosepalous* and *gamopetalous* respectively; whereas when the sepals and petals are perfectly distinct, as in the wall-flower, the words *polysepalous* and *polypetalous* are employed.

In certain cases, the calyx and corolla are undistinguishable, as in the tulip. Such two whorls are then called a perianth, while its parts are called leaves, and take the place of both calyx and corolla. The terms employed to express the cohesion or separability of its parts or leaves are *gamophyllous* and *polyphyllous* respectively.*

For the number of stamens, a word is formed by the union of the termination *androus* with a Greek numeral prefix. For the benefit of readers unacquainted with that language, we subjoin the numerals as far as they are required:—O, an; 1, mon; 2, di; 3, tri; 4, tetr; 5, pent; 6, hex; 7, hept; 8, oct; 9, enne; 10, dec; more than 10, *i.e.* infinite; OO, poly.

There are three other words occasionally required in the space appropriated to the description of the stamens; viz., *dynamous, adelphous,* and *syngenesious*. The first two are to be inserted opposite the word "filament," the last opposite "anther." *Dynamous* is used only in conjunction with the prefixes *di* and *tetra*, and the latter (*tetra*) exclusively with reference to plants of the order Cruciferæ, to indicate the fact, that of the six stamens, four are longer than two. Didynamous is likewise used for certain plants of the orders Labiatæ and Scrophulariaceæ, to show that of the four stamens, two are longer than two. The word adelphous requires the prefixes mon, di, tri, pent, and poly, and expresses the fact, that in these cases the filaments cohere into one, two, three, five, or many bundles or

* Professor Henslow adopted the word *perianth* exclusively for the petaloid division of Monocotyledons; for all dicotyledonous plants which exhibited no true distinction between the calyx and corolla, the outermost whorl was called calyx. Some botanists, however, employ the word *perianth* for the 4th section, Incompletæ, of Dicotyledons as well.

sets respectively. As examples of the first four kinds, may be mentioned the mallow, pea, common hypericum, and the tutsan hypericum.

The word syngenesious is to be used with all Compositæ, Lobeliaceæ, &c., where the *anthers* cohere but not the *filaments*.

In the last (uppermost) space devoted to "pistil, *carpels*," the words *apocarpous* and *syncarpous* are to be inserted, according as the pistil consists of one, or more than one, *free* carpel; or, when there are two or more *cohering* carpels. The pea, ranunculus, and rose, are instances of the first; the wall-flower, mallow, and tulip, examples of the second case.

Returning to our Wall-flower, the first two columns will now stand thus:—

Flower.	No.	Cohesion.
Pistil, *carpels*	2	Syncarpous
Stamen Filament Anther	6	Hexandrous Tetradynamous *
Corolla, *petals* Calyx, *sepals*	4 4	Polypetalous Polysepalous

The fourth column is headed "Adhesion," in reference to the fact that *different* whorls are frequently combined, or "adhere" together. Thus, in all species of the Rosaceæ, the stamens and petals will be found adhering to the calyx, and in the Compositæ, Umbelliferæ, &c., the calyx, corolla, and stamens are all adherent to the ovary.

We subjoin a brief description of the terms to be employed in this column:—

Superior and Inferior — If the calyx, or Monochlamydeous* perianth do not adhere to the ovary, the calyx is Inferior and the ovary Superior. If they adhere, the ovary is considered to be Inferior and the calyx Superior, the free portions of which, when present, appear as if inserted upon the ovary.

Hypogynous — Not adhering to the calyx or ovary, but inserted immediately on the floral receptacle.

Perigynous — Adhering partially to the calyx, or to a Monochlamydeous perianth, the free portions appearing as if inserted upon it.

Epigynous — Adhering partially to the ovary, the free portions appearing as if inserted upon it.

(Hypogynous, Perigynous, and Epigynous restricted to the corolla and stamens.)

Epipetalous — Stamens adhering partly to the corolla, their free portions appearing as if inserted upon it.

Gynandrous — Stamens adhering to both ovary and style, so that a central column is formed by them, upon which both anthers and stigmas are seated. As *e. g.* in the order Orchidaceæ.

* The word "Monochlamydeous" signifies *having only one floral envelope.*

We will now resume our examination of the Wall-flower. The sepals being easily removable, in consequence of no adhesion existing between them and the ovary, we insert the word "inferior" opposite to "calyx sepals;" and, for the same reason, we may at once write "superior" opposite to "pistil carpels." The corolla and stamens will be found "hypogynous," so that the fourth column is now complete; the fifth column being reserved for the classification. The Schedule will now stand as follows:—

Flower.	No.	Cohesion.	Adhesion.	Classification.
Pis. car.	2	Syncarpous	Superior.	*Class.*—Dicotyledon.
Sta. Fil. Anth.	6	Hexandrous Tetradynamous	Hypogynous.	*Division.*—Angiospermous. *Section.*—Thalamifloral. *Order.*—Crucifera.
Cor. pet.	4	Polypetalous	Hypogynous.	*Genus.*—Wall-flower.
Cal. sep.	4	Polysepalous	Inferior.	*Species.*—Common.

The sixth and seventh spaces are devoted to the Leaf and Inflorescence; for the former, the description is given under the following heads:—Composition (simple or compound); Insertion (petiolate, sessile, amplexicaul, &c.); Position (radical or cauline); Stipulation (stipulate or exstipulate); Form (ovate, lanceolate, &c.); Margin (entire, toothed, &c.).

For the inflorescence, there are two heads, viz.:—Character (spike, raceme, head, &c.); and Bracteation (bracteate, ebracteate, or spathed).

Such is as brief a description of the Floral Schedule as our space will permit. And we can but repeat, that if learners will only practise these exercises, they will be astonished to find what rapid progress they will make in the study of botany, and how greatly these schedules will increase their interest, and enhance that progress.*

* We cannot refrain from taking this opportunity of calling our readers' attention to an admirable little work on Structural and Systematic Botany (the systematic portion based upon material left in MS. by the late Professor Henslow), by Professor D. Oliver, who has long been accustomed to employ the "Schedule" in his lecture-room, and has embodied it in his new work. It is published by Messrs. Macmillan & Co.

PRE-HISTORIC DWELLINGS.

BY GEORGE E. ROBERTS, F.A.S.L.

UNIVERSAL Histories, in twenty or more folio volumes, which adorned the libraries of the last century, taught that the first habitation of man was a hut, an erection of wood somewhat resembling a Canadian log-cabin. The variety of this dwelling represented in the pictorial editions of these chronicles as the domicile of our first parents is the neatest of rose-entwined cottages; while in a picture of ancient British domestic life, exhibited by another of these encyclopædias of history, the family sit at the door of a house which, save that the windows are unglazed, more nearly resembles a *cottage ornée* in St. John's Wood than any home of a modern English peasant. But recent discoveries have dispelled these roseate views of the past. The earliest inhabitants of these isles of whom we have yet any evidences appear to have approached as nearly as any existing savage tribes to that perfectly primitive state of mankind for which ethnologists have as yet sought in vain. The domestic relics left by Celtic tribes in Britain are rude enough to dissipate the pleasing imaginings of the olden antiquaries; and as the existence of two pre-Celtic peoples has now been ascertained, it is scarcely matter of wonder that the remains of their dwelling-spots exhibit the simplest form of habitation conceivable. It would be beyond the limits of this article to trace the progress of these two pre-Celtic—Allophyllian as Dr. Wilson styles them—waves of the human race, or to show by the numerous examples afforded from their traces in Italy, Switzerland, Germany, Denmark, France, and the British Isles, that although, in a certain broad sense, their ages coincide with the three periods into which archæologists have portioned out pre-historic time—viz., the stone age, bronze age, and iron age—no sharp line of sunderance marks them, for one age not only graduates into another, but in many instances two sets of evidences are co-existent. I propose, therefore, to confine my remarks to an examination of the dwellings of these two pre-Celtic peoples according to the evidences which archæologists have obtained from a careful examination of their remains. The Cyclopean erections attributed to the first of these early races, cromlechs, megalithic

Fig. 1

Fig. 2.

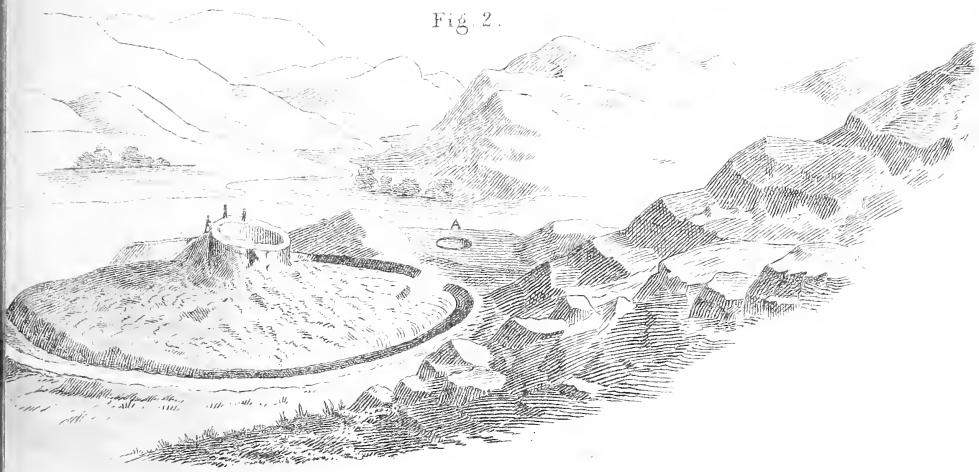


Fig. 3.

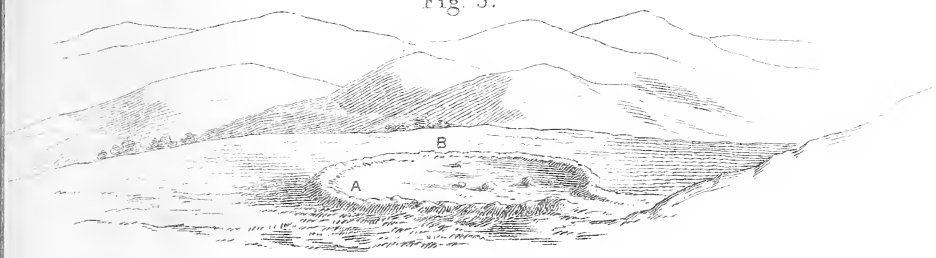
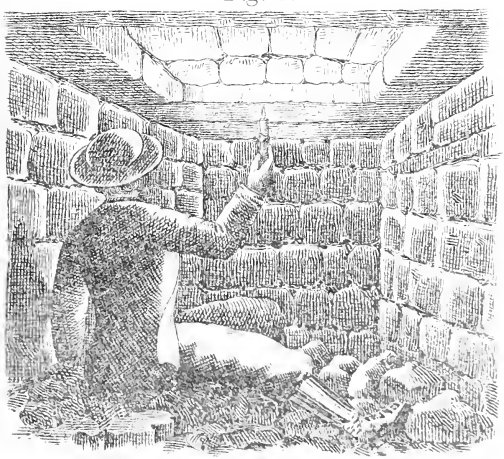


Fig. 4.



Jones del.

Pre-Historic hut-circles

circles, and cairns, we need not touch upon, our business being with the homes of the cromlech-rearers and cairn-builders. In this country very little has been done in investigating the very many hut-circles and other evidences of dwelling-spots which exist, chiefly in the North of England and Scotland. Had a tenth part of the labour been bestowed upon them which Continental archæologists have given to the examination of the Swiss and German lake-dwellings, some of which habitations are probably contemporaneous with them in time, a remarkable series of evidences might have been obtained. Enough, however, has been done to indicate the relationship between the pre-Celtic dwellers in North Britain and those of the Continent, and to exhibit the identity of their modes of life. The buildings which we refer to tribes of this age throughout Europe, are of three several, though closely related, kinds—viz., hut-circles, crannoges, and pfahlbauten, or lake-dwellings. Remains of the first class are to be sought for on dry moorlands. They have been met with on Clava Heath near Culloden, in Helmsdale in Sutherlandshire, on Yevering Bell in the Beamish Valley, and other localities near the Cheviots, by Mr. George Tate, and at Keilder (Northumberland) by the Rev. G. R. Hall; but in all these examples from the Border country, the hut-circles were grouped closely together, and surrounded with a defensive line of earthworks. It is also probable that they were of younger age than the Helmsdale circles; indeed, although their existing remains resemble those of the elder time, they have been described by Mr. Hall as being comparable in their inhabited condition with the wattle-work huts of the Britons of the seventh century. These were all undoubtedly land-dwellings. Perhaps the Hottentot kraal is their nearest modern analogue. The examples which I figure as typical of the class are from Helmsdale, and to them I shall hereafter refer.

The present appearance of these and other hut-circles which may be attributed to a pre-Celtic people is simple enough. A ring of stones gathered from the moor marks out the limits of the primitive house, and a broad flat slab in the centre points to the hearthstone of the family circle. It can scarcely be supposed that this simple home was entirely naked of covering, but as yet we have but the slightest reason for believing that a circle of erected logs supported a rude roof of wattle or timber, or entwined heather. Sufficient time, however, has passed since the circles were tenanted to account for the absence of every fragment of a sheltering roof, and the conservating element of water is absent, into which the erection, when it fell, might have sunk, as did the timbers of the lake-dwelling, and been preserved. The "kitchen

middens," which have of late been met with in various parts of Northern England and in Scotland, have a natural connection in time with, and domestic relationship to, these hut-circles. Among the most interesting of these, are the groups occurring on the Bennet Hills near Burghead, those upon the Tarbotness Promontory, the shores of the Dornock Firth, and upon the sand-dunes near Cromarty. Perhaps the most curious example met with as yet in England is that of Normanby, in Cleveland, which possesses the remarkable geological fact of now being covered with eighteen feet of ochreous clay. I need not here remark upon the great number of similar accumulations met with in Denmark and elsewhere upon the Continent, remains which have been lately seen to have their exact parallels in Northern America, as in the States of Maine and Connecticut.

The existence of many curious stone-encircled dwelling-spots in Ross-shire and Sutherlandshire, analogous in character to the hut-circles in the Cheviots, has long been known, but no archæologist has yet taken them in hand, nor has any anthropologist endeavoured to connect them with a particular ancient people. In form these "lodges," as we may almost call them, are flat spaces chosen out of the moorland, generally along a line of terraces, or upon a rising elevation, and marked out as a habitation by being girt about with a single line of whatever large stones or rock-fragments the neighbourhood furnished. Generally their diameter is from six to eight yards. In the centre we occasionally find the hearthstone, a smooth flat slab, usually of red or grey sandstone. Around and about this, bones of the animals eaten have, in some examples, been found, beaten and trampled into the ground, and mixed with some few sea-shells and with many fragments of charred wood; the appearance of this compost being much the same as that of the great slabs of stalagmite (lately exhibited at the learned societies in London) which formed the floor of the bone-cave of Les Eyzies in the Dordogne, except that no stalagmite is present. Two very typical "circles" referable to this group I visited last year. These were situated upon a heather-clad moor about two miles west of Edderton (Ross-shire). My stay, however, in the district was too short to permit a close observation either of these or of other circles of like kind existing in the neighbouring valleys. Since my return the investigations have been carried on by my friend the Rev. Mr. Joass of Edderton, whose discoveries go far to prove that the ground-surface of these hut-circles was the dwelling-place of the primitive family during summer only, a subterranean apartment, rudely walled with slabs, housing them during the winter months.

The character of these remarkable dwellings will be best seen by referring to the sketches on Plate XV., figs. 1, 2, 3, 4. In explanation of these Mr. Joass writes as follows :—

"Our principal explorations of late have been in a glen running from Helmsdale; about four miles from the entrance to which the sketch (fig. 1) was taken. Here we observed a circle (A), 48 feet in diameter, formed of rude boulders and smaller stones, with an entrance to the S.E. Wishing to press on to the examination of another circle beneath which a subterranean passage had been discovered, we made no digging here. From A was visible B and C, which I had previously explored, and a heap of stones well up on the hill at D, which looked extremely tempting. B is a cairn, 142 feet long and 10 feet high, composed of small river-rolled stones. At its higher end is a small opening, into which I entered and penetrated to a distance of 12 feet along a passage 3 feet high and 2 feet wide, formed by rude upright stones roofed by similar slabs. Further ingress was prevented by the falling-in of the roof. Near the end I found a portion of a human skull, uncommonly thick, and a periwinkle shell. C (fig. 1) is a kiln-shaped structure, though there is no evidence that it was ever used as such, no scrap of limestone or ironstone being near. Moreover, it is in a granite district. D (fig. 1) is a ruined tower, situated on the shoulder of a hill commanding a most extensive view to the N., S., and W. This may be of Pictish age and origin. About a quarter of a mile from it, on a small shelf or terrace, there is a circle (fig. 3) similar to that marked A in fig. 1. In its inner circumference was a small opening, creeping backwards into which with a lighted candle I found myself in a subterranean passage, following the line of the circle for about 30 feet, and being at its termination 6 feet below the surface (fig. 4). Three feet from the end of this passage a square opening in the roof, closed from above by irregularly-shaped stones, appeared to have given communication with the surface. The height of the passage was 5 feet, and its width 3½ feet. Was this the sleeping-apartment, or the winter residence of those who occupied the upper circle in summer time? Other similar excavations are said to have been so used by the pre-historic people. One solitary shell, a periwinkle, was all we found in it."

Here, then, we have a new group of archæological studies opened to us, one which promises an excellent fruitage of pre-historic evidences, and which will be of the greatest value in our determination of the ethnic position of this ancient Highland people. Whatever light is to be thrown upon their lives must be from modern investigation; nothing in past writings is likely to aid us; although Bayle, in his "Dictionary," supports the opinion that Abaris was a Highland Scot! Nor as yet can we say anything as to their positive age, or their relations in time with other pre-historic dwellings of different character. Possibly these hut-circles, with their subterranean winter retreats, were dwelt in contemporaneously with the lake-lodges of Switzerland and the crannoges of the Irish loughs; for even with a larger measure of knowledge con-

cerning them, it may not be possible to regard the age of the one as older or younger than that of the other.

Before passing on to the second group of pre-historic dwellings, I am inclined to remark upon one possible class of evidences to be obtained in certain parts of our island, as to the existence of another variety of dwelling-spot. Many rocky cliffs in the Dordogne have been observed by Mr. Christy and M. Lartet to be pierced with holes, arranged in lines, and having undoubted marks of design in their formation. These holes are always met with beneath an overhanging part of the cliff, at places where such a beetled brow would form a roof-tree for a dwelling, fixed by means of inserted poles against the face of the rock. Ascending lines of holes have also been noticed, into which it was probable that "rounds" of a rude ladder were inserted to enable the dwellers in these "arbres" to reach their homes. Not the slightest remains of any such dwellings have yet been found, but the undoubted artificial character of the holes renders their existence probable. Similar holes, in precisely identical natural situations, have been often noticed by myself on the face of the soft red sandstone cliffs which form escarpments to the diluvially-scooped valley of the Severn, and in many lateral valleys in its near neighbourhood. And I would here suggest that a careful examination should be made in those districts, more especially along the cliffs at Kinver and Cookley, in Staffordshire; Kidderminster and Wolverley, in Worcestershire; and Bridgenorth, in Shropshire. The age of these dwellings is considered by the French archæologists to be intermediate between the cave-dwellers (whose "homes" do not come into our list of erections) and the hut-circle men.

One second form, or rather group, of dwellings we find typed by the crannoges of the Irish bogs. These, though diversely constructed, by being raised upon an artificial foundation of piles surrounding and supporting a floor of beaten clay and twigs, appear to be nearly allied in character to the hut-circles; and if we regard this variation in design as dependent upon the natural features of the country, they may be referred to the work of the same pre-Celtic people. Indeed, Professor Harkness, from an examination of a remarkable example at Drumkeerey Lough, near Bailieborough, county Cavan, considers that the crannoge was not originally formed upon an artificial island, but on land, either island or promontory, but little raised above the level of the lake; and that its foundation had to be changed from a natural to an artificial one by reason of the peat invading the shores, filling up the creeks, and so lessening the area of the lake and deepening the water. "The gradual rise of the water compelled the crannoge-dwellers to raise their floors, and so give them the

artificial base, which has been regarded by some archæologists as the first process in the building of these structures." An excellent memoir upon this Drumkeerey crannoge has been lately read before the Society of Antiquaries, by Professor Harkness. He describes the basement of the structure as consisting of several thousands of birch-poles, covered with the original bark, having a wedge-shaped end driven into the ground in close proximity to each other. Later in the history of the dwelling this foundation was repaired by a number of oak slabs pointed at the lower end. The shape of the crannoge was pyriform. Inside the piling appears evidence of a floor laid with stones and earth brought from the mainland to the island. Near the centre of the crannoge are the remains of fireplaces formed of immense blocks of stone, surrounded with large quantities of charred wood and fragments of bones. Remains of coarse pottery were also found, also beads of amber and glass, stone rings, and a corn-crusher of ruder form than a quern. The entrance was strengthened by two rows of piles, from the outer end of which a stockade seems to have run. Many crannoges of similar design have been met with in Ireland, and described by the local archæologists; but as the Drumkeerey one illustrates that principle of formation which I believe to the true one, I have chosen it as a type of the class. Lacustrine human habitations have lately (1863) been discovered in Dowalton Loch, Wigtonshire; upon these Lord Lovaine read a paper at the Newcastle meeting of the British Association. This loch having been drained, artificial islets were found in it, staked out by piles strengthened with stones, the foundations of dwellings formerly above the water-surface, but afterwards, by the growth of peat, and probably also physical changes in the district, sunk below it. There is every probability of lake-settlements existing in many of our shallow English lakes, if observation was directed to their discovery.

We now pass on the lake habitations of Switzerland, more than 160 of which have already been found. So much has been written about them within the last few years, and so generally are their characteristics known, not only to the scientific world, but also to the reading public, that a *résumé* of the investigations of Morlot, Keller, Lyell, Lubbock, Desor, Schwab, Forel, Ullmann, Colonel Suter, Gilliéron, Troyon, and Rochat appears to me scarcely necessary. Sir C. Lyell has exhibited, as the frontispiece to his "Antiquity of Man," a restoration of a group of these dwellings, after a design by Rutimeyer, showing their probable near affinity in character to the beehive-shaped huts, elevated upon piles, slightly above the shallow waters of the Papuan archipelago.

Such dwellings are now tenanted by the Kouaoui people of Doree (New Guinea) and by those of Masmapi, though perhaps the simplest form of lake-habitation now dwelt in is that erected by the Pilotis tribe, in the near-lying island of Rawak.

The lake-habitations of Switzerland have been divided by Mr. Lubbock and other archæologists into three classes:—"Firstly, those in which all the instruments are made of stone and bone, and which may therefore be said to belong to the stone age—about fifty of these lake-villages have been described; secondly, those in which objects of bronze also occur—establishments of this class are even more numerous; and, thirdly, those in which implements of iron have been discovered—only a very few of these are as yet known." It must, however, be borne in mind that archæologists are united in their opinion that the three ages of stone, bronze, and iron "represent states of civilization rather than actual chronological horizons."

Dr. Keller's investigations have, perhaps, been the most constant; and he has, from time to time, embodied the discoveries, as they have been made, in reports with which he has enriched the "Transactions" of the Archæological Society of Zurich. Without, therefore, alluding farther to these discoveries which have been made known and commented upon throughout Europe, it may suffice to call attention to the last (5th) Report of the series. A convenient *résumé* of this has just been circulated by M. Morlot.

The lake-dwellings therein described are those in the Duchy of Parma, met with in accumulations of fresh-water mud near the present river margin. In this fluviatile material, Professor Strobe and Signor Pigorini of Parma had met with the sites of several dwellings, from which they had obtained fragments of wood and cinders, and the bones of animals, together with a curious assemblage of art-objects in bone, stone, and bronze; in the latter material were axes, sickles, arrow-heads, sword-blades, hair-pins, a small comb, scissors, and an awl. The pottery was of coarse clay, mixed with sand, resembling in its character the rude kind still made by hand in the villages among the Apennines. The pots found had small handles, and were sometimes ornamented with stripes. Among the bone objects were combs, exhibiting a like ornament to those of bronze. A basket made of osier was also met with. The animal bones found belonged to wolf, wild-boar, roebuck, stag, dog, pig, horse, bull, goat, and sheep; bird bones were also met with. Remains of fruits also came to light from out the mud—which were so well preserved as to be easily referred to pears and plums. Flax-seeds were also found. On the site of a similar lake-dwelling at Peschiera,

M. de Silber found objects of like kind, together with some in copper. A lake-dwelling of probably earlier date is one met with beneath five feet of peat, near to Zug, from which articles of stone have alone been obtained. At Untersee, south of the village of Constance, and on the borders of that lake, M. Dehoff found no trace of a bronze age or of metal at all. At Nieder-Wyl, an establishment of very early type was met with, though an important one by reason of the excellency of its preservation. Passing northwards, M. Escher contributes an account of a hill-dwelling, near l'Ebersberg, of character very similar to those lake-dwellings of the bronze age which occur in the Lake of Brienne. The lake-dwellings of Robenhausen are worthy of note, those first discovered being of the bronze age; but on removing their relics, a lower foundation was seen, belonging to an older encampment.

It is tolerably certain that some of these lake-dwellings were tenanted up to—it may be after—the commencement of the Christian era. Evidences of the influence of an exterior civilization greater than their own are clearly to be seen in the character and ornamentation of some of their bronze and iron implements; and the discovery of substances such as tin, nephrite, Mediterranean coral, and Baltic amber, among the relics of their homes, prove that the people who clung so tenaciously to the dwelling-spots of their ancestors were not insensible to the advantages of communication with European nations.

And this contemporaneity of a low class with a cultivated people has still its counterpart in the world. The hill-tribes of India, the Veddahs of Ceylon, and the various "men of the soil" who live in the mountain fastnesses of the Malayan peninsula, are so many stagnant patches of human life, huddling together in the midst of active races, and holding fast by a few degrading traditions. By laws of human progress—and who shall say that "natural selection" is not the greatest of these?—the nations in the midst of whose social lives they lie hidden have advanced to higher stations, while they have remained stationary, or as laggards in the scheme. And yet another law they may be regarded as exemplifying,—that which, though at present it is shadowed rather than laid down, teaches the chronology of natural phenomena to be a series of overlaps, the evening of one condition of terrestrial things having been, and still being, co-existent with the morning of the succeeding era; a most reasonable and philosophic element in our comprehension of geological phenomena, and one for which we may claim an equal value among the laws of human progress.

REVIEWS.

ANTIQUITY OF MAN.*

IS the Mosaic chronology to be relied on in forming an estimate of the immense period which has elapsed since man made his first appearance on the globe? Are we to believe that the human race was first created *six thousand* years ago? Both questions must be answered in the negative. The mass of evidence—geological, archæological, and zoological—which supports the conclusion that man has been upon the earth for a period of more than a thousand centuries, is almost overwhelming. This evidence is the result of the laborious and persevering researches of such men as Schmerling, Boucher de Perthes, Falconer, and Lyell, who have devoted themselves to the advancement of palæontological science. The last-named *savant*, who is as remarkable for his great powers of observation as for his clear reasoning faculties and his lucid style as a writer, has given us, in the work now under notice, a grand survey of what has been done in the branch of science on which he treats. There are few subjects upon which so many memoirs have lately been written as that of the antiquity of man. Man's age having been in part ascertained by an inquiry into his co-existence or non-co-existence with certain fossil mammals, and the latter being discoverable in the deposits found in caverns, the subject of bone-caves is one now attracting considerable attention. This portion of Sir Charles Lyell's work appears to be most exhaustive. We observe detailed accounts of the characters presented by the caverns of Belgium, France, Sicily, England, and especially of those known as the *Engis* and *Neanderthal*, famous as having contained the skulls bearing their names, and which some time ago produced such a commotion in the scientific world. The chapter on the peat-mosses of Denmark is of decided interest, inasmuch as it furnishes a species of evidence which, from being untrammelled by collateral geologic speculation, can be easily appreciated by an ordinary reader. It helps, at the very outset, to show that the age of man, as a race, has been under-estimated. Sir Charles having alluded to the extent and depth of the Danish peat, observes, "Around the borders of the bogs, and at various depths in them, lie trunks of trees, especially of the Scotch fir (*Pinus sylvestris*), often three feet in diameter, which must have grown on the margin of the peat-mosses, and frequently fallen into

* "The Geological Evidences of the Antiquity of Man, with Remarks on Theories of the Origin of Species by Variation." By Sir CHARLES LYELL, F.R.S. Third Edition. 1863. London; Murray.

them. This tree is not now, nor has ever been in historical times, a native of the Danish islands, and when introduced there, has not thriven; yet it was evidently indigenous in the human period, for Steenstrup has taken out with his own hands a flint instrument from below a buried trunk of one of these pines. It appears clear that the same Scotch fir was afterwards supplanted by the sessile variety of the common oak, of which many prostrate trunks occur in the peat, at higher levels than the pines; and still higher, the pedunculated variety of the same oak (*Quercus Robur*) occurs, with the alder, birch, and hazel. The oak has now, in its turn, been almost superseded in Denmark by the common beech." The trace of the first race of men—that of the stone age—having been found beneath the peat deposit containing the pines, which have never been known to live in Denmark, and which must have taken of themselves centuries to acquire the bulk described above, affords us some idea of the enormous lapse of time which must have intervened between the period of the formation of that single flint weapon and the present day. The testimony supplied by the shell mounds of various countries, and the ancient Swiss dwellings, is given at length; and on the subject of *upraised strata* in Sweden and Norway, the information is most copious. In calculating the time required in elevating those deposits of Norway, some of which, containing recent shells, reach a height of 600 feet, Sir Charles writes,—"A mean rate of continuous vertical elevation of two and a half feet in a century would, I conceive, be a high average; yet, even if this be assumed, it would require 24,000 years for parts of the seacoast of Norway, where the post-tertiary marine strata occur, to attain the height of 600 feet." The Neanderthal and Engis skulls have their respective merits well discussed, and on this matter we are treated to an admirable extract from Professor Huxley's recent work. In regard to the fossil man of Natchez, the author does not concur in the opinion of some geologists that the human race and the mastodon were contemporaries. The chapters on the glacial period are most important, and embrace a series of maps illustrating the successive revolutions in physical geography during the post-pliocene period. In these we are shown what portions of the British isles would remain above water if the whole area subsided to a depth of 600 feet; and also what portion of our present sea would become land if there was a general rise of the area of north-west Europe to the extent of 600 feet.

Not the least interesting portion of the volume before us is that which relates to the various theories framed from time to time to explain the origin of species. The author, who, be it known, is an advocate of Mr. Darwin's doctrine, gives a brief sketch of the hypothesis first framed by Lamarck. The latter, who may be said to have been the first who openly denied the truth of the theory of the *creation* of species, came to the conclusion that none of the plants and animals which now exist upon the globe were primordially created, but had descended from pre-existing types. This variation he believed to be due to various external causes, such as soil, climate, temperature, &c., and he explained the continuance of the original forms from which the new ones were derived, on the supposition that the germs of living things were constantly making their appearance upon the globe. He accounted for modifications of form by saying,

that just as some organs become strong and others weak, so may certain portions of the body become obsolete and others attain a superior development. Lamarck did not stop here, but, as our author remarks, "not satisfied with such legitimate speculations, the French philosopher conceived that, by repeated acts of volition, animals might acquire new organs and attributes; and that in plants, which could not exert a will of their own, certain subtle fluids or organizing forces might operate so as to work out analogous effects." Herein we see that Lamarck went a step too far, and herein lies the great line of distinction between his hypothesis and that originated by Mr. Darwin. There has been an outcry raised against the theory of the latter, on the ground that it was the same as Lamarck's; but this imputation was cast by good folk, who never tried, or were too dull to understand, either one hypothesis or the other. Mr. Darwin never supported the theory of spontaneous generation, which was employed by Lamarck, nor did he ever suppose that the variation of a species depended upon the volition of the individual. He simply maintained that new forms rose from pre-existing ones, from the circumstance that, in the ordinary struggle which every animal has for life, those of any brood which had the greatest physical powers (no matter in what direction those powers lay) had the advantage; and that, whilst the weaker members were unable to obtain the conditions necessary to their existence, the stronger were enabled to live, and hence to perpetuate, in intensified form, the peculiar qualities they possessed. Sir Charles Lyell gives the following clear distinction between the two theories:—"Lamarck, when speculating on the origin of the long neck of the giraffe, imagined that quadruped to have stretched himself up, in order to reach the boughs of lofty trees, until by continued efforts and longing to reach higher, he obtained an elongated neck. Mr. Darwin and Mr. Wallace simply suppose that, in a season of scarcity, a longer-necked variety, having the advantage in this respect over most of the herd, as being able to browse on foliage out of their reach, survived them, and transmitted its peculiarity of cervical conformation to its successors." The author supports the theory of progression on a geological basis, and agrees with Huxley, Marshall, Rolleston, and Flower in believing that the brain of man does not differ from that of apes in having the cerebellum covered by the cerebrum. The appendix will be found extremely useful, dealing as it does with the subject of several very recent discoveries, including, among others, that of the Moulin Quignon jaw-bone.

We think our readers (even those ignorant of geology) can with advantage peruse Sir Charles Lyell's splendid treatise, which is certainly one of the least technical and most philosophic works we have ever met with. Every geologist must possess it, and every one who desires to know what palæontology is doing, should be familiar with its pages.

THE SOURCE OF THE NILE.*

IT may be said, as a rule, that books of travel do not contain matter in proportion to their bulk. The work which Captain Speke has presented to the public cannot be regarded as an exception to this general statement. It is a very large book, so large that its price alone would prevent its ever attaining a place in the libraries of ordinary readers of this class of literature. The text extends over nearly six hundred pages, and we are certainly of opinion that the author might have given us all the information it contains in at least one-third of the space. In regard, however, to its mere mechanical qualities, too much praise cannot be bestowed on the publishers, who have sent out a volume exquisitely and profusely illustrated, and which in point of type is one of the best executed examples we have seen for some time.

The author's object has evidently been to produce a popular work, and this object we think he has achieved with tolerable success. We fancy, nevertheless, that had science been introduced in certain portions, this "Journal" would have lost none of its merits as a readable production, while it would have gained, as a book of reference, some considerable reputation. No doubt there are many who will think that the various appendices, containing lists of plants, &c., are sufficient to fill the gap we have alluded to, but it must be borne in mind that these are the work of Captain Grant, and not of the author of the present volume, and that however valuable "cut-and-dry" lists may be to the specialist, they are absolutely worthless to the amateur. We do not wish to be considered hypercritical, but when we find a voluminous essay upon the character of a newly explored country devoid of accurate information concerning the geology, botany, and zoology of the regions investigated (?), we should not be acting conscientiously were we to make no comment upon such omissions. It cannot be denied that the work is of an interesting character, and that the information conveyed by it is both instructive and novel. On the other hand, the style is far from being what it ought to be. Captain Speke's observations appear in many instances to have been very hastily made, and his conclusions are in some cases far from being logical. Let us justify these assertions. The passage we select as an example of the peculiar phraseology adopted in several cases by the author, alludes to a rather animated discussion between one of his domestics and himself. "Foaming and roaring with rage, Bombay said he would not stand being thus insulted. *I then gave him a dig on the head with my fist.* He squared up and pouted like an enraged chameleon, looking savagely at me. I gave him another *dig*, which sent him staggering. He squared again; I gave him another; till at last, as the *claret* was flowing, he sulked off." * * * "But Bombay showing his *nozzle* rather flatter than usual," &c. We must confess that, apart from these little friendly communications between master

* "Journal of the Discovery of the Source of the Nile." By JOHN HANNING SPEKE, Captain H.M. Indian Army, &c. London: Blackwood & Sons. 1863.

and man, we deem the language better suited to the columns of *Bell's Life* than to those of the book lying on our table. We certainly are at a loss to understand the anatomical impossibility of standing observed by Captain Speke in the female monster of obesity which he describes. Passing over his description, which *we* will not say is more prurient than it need have been, we come to examine the measurements of this *monster*. What are they? Certes nothing to surprise us. The following are the dimensions as given by the author:—"Round arm, 1 foot 11 inches; chest, 4 feet 4 inches; thigh, 2 feet 7 inches; calf, 1 foot 8 inches; height, 5 foot 8 inches." It is just possible that Captain Speke has given the above figures as indicating two different estimates: for example, he may mean that the first represent circumference, and the others diameter. If this be the case, he has pursued a very blundering method of communicating the results. Then, indeed, the woman may be regarded as a curiosity, and we are at fault in supposing that the writer's powers of imagination were overexerted. Here again, however, we fancy we detect a flaw in the evidence. Why should the arm of a quadruped-moving woman be only 1 foot 11 inches in circumference, when the chest attained the enormous girth of nearly 14 feet?

There are many other portions of this "Journal" which are equally suggestive, but lack of space obliges us to draw our comments to a conclusion. Notwithstanding the failings we have referred to, Captain Speke's book contains a great deal that is both amusing and instructive, and doubtless many will consider it a work which deserves a high position in its own department of semi-scientific literature.

NATURAL HISTORY OF THE HERRING.*

THIS is a beautiful book, well conceived, and stored with the experiences of one who has made a world-renown in connection with the Scotch herring fisheries. The volume which lies upon our table is in part the reproduction of an original memoir published in the Reports of the British Association, but the great bulk of the letter-press is quite new. It may be said to be divided into three distinct sections: in the first, the natural history of the fish is given most diffusely; the second relates to the modes of fishing and curing; and the third, which constitutes the major portion of the entire text, is devoted to the chronological history of the herring. The author's original observations and researches are chiefly confined to the first subdivision. They are the most valuable portion of the entire book. Mr. Mitchell does not agree with Pennant and others, who imagine that the herring is a migratory fish, and he gives us a series of objections to the view formerly held, while at the same time he adverts to the fact that the author of the article "Icthyology" in the last edition

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* "The Herring; its Natural History," &c. By JOHN M. MITCHELL, F.R.S.S.A., &c., &c. Edinburgh: Edmonston & Douglas. 1864.

of the "Encyclopædia Britannica," admits the accuracy of the old and exploded doctrine. McCulloch is also taken to task on the same score. M. Valenciennes and the writer are at issue on several points, and Mr. Mitchell clearly indicates a few of the French naturalist's errors, especially those concerning the supposed want of discrimination shown by the herring in selecting its spawning-bed. We are treated to an extensive list of the enemies of the herring, and of the creatures on which it feeds; a few pages being also devoted to the zoological and anatomical characters of the fish. We think this latter is the least important portion of the volume, for the descriptions are of an exceedingly general character, and the comparative anatomy of the animal is by no means fairly dealt with. Section 2 is very interesting, and gives an amount of instruction upon the methods of fishing and curing herrings in different countries which cannot be found elsewhere. The concluding portion of the essay is the most voluminous of all; it embodies a history of everything connected with herrings and fisheries from the year 495 down to that of 1862. We have only to ask Mr. Mitchell one question. Why did he not (as his book was published in 1864) examine the Commissioners' Report to Parliament in 1863, and give us his opinion on it? In publishing the present volume he has conferred a signal benefit on science, and has supplied the public with a most readable and instructive treatise. It is, we believe, the most copious monograph that has ever been written on the natural and chronological history of a single animal.

THE SECOND STEP IN CHEMISTRY.*

WE here thank Mr. Galloway for compiling the volume bearing the above title. It is a book which was much wanted, and will be a great boon both to lecturers and students. It is intended for a higher class of readers than those who sit upon the theatre-benches in the capacity of "first-year's-men." The author has spared himself no amount of labour in bringing out this "second step;" and it may with safety be averred that the result reflects equal credit on him as a thoroughly well-read chemist and an able exponent of the subject which he professes to teach. This textbook may be said to embody everything that is at present known regarding philosophic chemistry; and while it contains all that concerns the theoretical branches of the science, it is also adapted for employment as a book of reference by those pursuing a series of practical organic investigations. The views of all the modern English and Continental chemists find a place in Mr. Galloway's manual, so that the student is not treated to an author's hobby, but has the option of selecting those opinions which appear to be supported by the greatest weight of evidence. The

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* "The Second Step in Chemistry, or the Student's Guide to the Higher Branches of the Science." By Robert Galloway, F.C.S., Professor of Practical Chemistry in the Museum of Irish Industry. London: John Churchill. 1864.

laws regulating the constitution of bodies are concisely stated; their history and progressive development being described at some length, the writer beginning with the discoveries of Clarke and Griffin, and terminating with those of Gerhardt, Laurent, Williamson, Frankland, Kolbe, and others. Exercises to be worked out by the reader are scattered through the text, and the appendix contains a useful list of questions given by various examining boards. We trust Mr. Galloway's handbook may meet with the encouragement it deserves; it commends itself to every serious student of chemistry.

NATURAL PHILOSOPHY.*

OF the three volumes which we are about to notice, the first is unquestionably the most important. It treats of mechanics, hydrostatics, pneumatics, hydraulics, acoustics, and animal mechanics. The style is vigorous and clear, and the language is so characterized by an absence of technicality, that the book may be read with as much advantage by an ordinary reader as by a student. The author does not confine himself to mere descriptions of machinery and explanations of their mode of action, but allows a wholesome and philosophic tone to pervade his remarks, by which the reader's mind cannot fail to be improved. That stumbling-block of amateur mechanics, the centre of gravity, is explained in the simplest manner; and the chapter on the science of music furnishes more details than are usually to be found in works like the present one. The different laws of natural philosophy are tersely and popularly expressed, and the diagrams, which are numerous, are simple and explicit. The least accurate portion of Dr. Arnott's production is that which relates to pure physiology. The statement that, till two hundred and fifty years ago, man was "ignorant of the fact that the blood in his own body is constantly travelling from the heart to all other parts and back again," is not exactly correct. On consulting M. Flouren's essay, "Histoire de la Découverte de la Circulation du Sang," Dr. Arnott will perceive that even in the time of Cæsalpinus, the expression "circulation of the blood" had been employed.

Mr. Lynn's little volume, though of modest size, is very well executed, and as a student's manual takes a higher rank than the work just noticed. Its object is to supply in a small compass an account of the fundamental principles of the sciences of mechanics, hydrostatics, hydraulics, pneumatics, and optics. It is clearly written, and, without pretending to be a popular treatise, may be read by those familiar with the early books of

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* "Elements of Physics, or Natural Philosophy." By NEIL ARNOTT, M.D., F.R.S. London: Longman & Co. Sixth edition. Part I. 1864.

"First Principles of Natural Philosophy." By W. T. LYNN, B.A., &c. London: Van Voorst. 1863.

"The Ghost as produced in the Spectre Drama," &c. By HENRY DIRCKS, C.E. London: E. & F. Spon. 1863.

Euclid and elementary algebra. The method of estimating the velocity of falling bodies (a puzzling subject to the beginner) is more lucidly explained in this little work than in any we have yet seen.

"The Ghost," in one sense, explains by its title the nature of its contents; that is to say, on looking at the title-page one fancies he has caught the meaning or intention of the author, but he has not done so in reality. The work is apparently a popular treatise on optics; in point of fact, it is nothing of the sort. It is true that there are a few paragraphs to be found which relate to the so-called spectre drama; but the greater portion of the volume is engrossed by a diatribe which the author launches against Mr. J. H. Pepper, of the Polytechnic. His censures are couched in the most bitter terms, and are far from interesting to the general reader. However satisfactory it may be to Mr. Dircks to indulge in invective against one by whom he feels himself injured, it is decidedly unjust to make the public unwilling purchasers of his printed censures. This he has done by giving to his work a title which does not adequately express the nature of its contents.

PRACTICAL TELEGRAPHY.*

IN these days, when telegraphic communication has reached almost the acme of perfection, and messages are transmitted from town to town with a velocity approaching that of lightning, all who are professionally connected with the telegraph service are supposed to be acquainted not only with the practical but also with the theoretical bearings of the electric forces. We are sorry to think that till the publication of Mr. Culley's excellent handbook, there was no proper means by which the telegraph official could make himself acquainted with the information we allude to. This was a great fault. An ignorance of the principles of an art deprives us of the advantages which would accrue to the country, were many minds given the opportunity of framing new ideas tending to the improvement of our machinery and apparatus. It is therefore with great pleasure that we welcome Mr. Culley as an instructor. In the first portion of his work, the author treats us to an able account of the sources of electricity and magnetism, and winds up by showing the connection between, or, as Mr. Grove would express it, the correlation of the two forces. The fundamental principle of the telegraph is clearly explained; in a series of well-executed diagrams we are shown how a current of electricity, when passing over a magnetic needle, causes the latter to assume a position at right angles to the course of the current, and how the deflection of the needle to the right or left depends on the direction of the current as regards the poles of the needle. In the more technical section of the volume, the subjects of *faults*, *derived circuits*, *testing for insulation or resistance*, and *testing for faults* receive the author's attention. A

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* "A Handbook of Practical Telegraphy." By R. S. Culley, Telegraphic Engineer and Superintendent. London: Longman & Co. 1863.

separate chapter is devoted to descriptions of the various forms of printing telegraphs, including those of Morse and Bain, and here also we find an explanation of the nature and action of relays. Mr. Culley does not appear to approve of the "Cooke and Wheatstone" needle telegraph. The remainder of the volume is devoted to the question of telegraphic engineering, the construction of a line, &c., and will be found exceeding useful by those whom it concerns. The "Handbook of Practical Telegraphy" is especially addressed to telegraph officials, and we can confidently recommend it to all who are interested in telegraphic technology.

PARASITIC FUNGI.*

WHEN specialists in any branch of knowledge leave for a while their pursuit of original investigations, and give us in printed form the results of their experiences, these productions are usually valued. The author of the present volume is well known to English physicians, as a skilled original observer in the department of parasitic skin diseases, and he has lately published the work before us. Let us then admit at the outset that we have not been disappointed. Dr. Tilbury Fox's volume is one calling for the immediate attention of the *dermatologist*, and is furthermore one from which the student of microscopic fungi may acquire a great deal of useful instruction. We cordially approve of the classification of *Tineæ*, which the writer has adopted, and we have little doubt that even if further pushed, his scheme would prove advantageous to the science of the profession. As an instance of how Mr. Fox treats his subject, we may take the example of *Tinea polonica*, that curious and unpleasant disease of the hair which occurs so frequently in Poland, Russia, &c. The history of the affection is given at length, the views of all the physicians of distinction who have studied it are tersely expressed, and finally the treatment is given in the second portion of the volume, which embodies the clinical observations of the author. The comments on the "Fungus foot" of India are of deep interest. When Dr. Fox speaks of the physiology and pathology of these parasitic maladies he is evidently in his element, and admits us to enlarged views of the subject, which it is to be regretted are absent from too many medical treatises in this age of book manufacture. The chapter on the variation of fungi is of the greatest importance, and throws an entirely new light on the diagnosis of skin diseases; moreover it lends, though in an *indirect* manner, a helping hand to Darwin's theory. There are three stages of treatment which follow in physiological sequence from the study of the disease. 1st. To remove the soil or pabulum which assists the growth of the fungus. 2nd. To destroy the remnants of fungous growths; and 3rd. To promote the re-growth of the hair and other injured tissues. Four plates executed in part by wood

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* "Skin Diseases of Parasitic Origin, their Nature and Treatment." By W. Tilbury Fox, M.D. London: Robert Hardwicke. 1863.

engravings, and in part by *kerography*, accompany the volume; the first of these, which illustrates the action of *Tinea* on hair, is very well done indeed, and had the magnifying power employed been higher would have been of much interest to the histologist, as showing the pathological condition of the parts. In our opinion the profession is greatly indebted to Dr. Fox for his admirable essay.

LIFE AND DEATH.*

SOME time since Mr. Savory delivered four lectures on the above subject, at the Royal Institution. It is these which are now printed. They are an interesting and sketchy account of the relation which exists between the two conditions. We admire Mr. Savory's style as a writer and lecturer, it is both elegant and exact. We think too that his lectures are calculated if not to explain the nature of life, at all events to awaken in the minds of most persons a desire to become more conversant with physiological laws. Viewed from this aspect, the tendency of the little volume is a good one. The pages of Mr. Savory's lectures abound in generalization, and it must be confessed that he has left nothing undone to induce in his audience a keen appreciation of the beauty of natural laws, and of those sublime speculations which first emanated from the great Von Baër. The importance of studying comparative anatomy, in order to arrive at a true conception of the complexities of the human organism, is adverted to in impressive terms, and the distinction between the generalization and specialization of organs is briefly stated. Still, with the exception of reference to the general phenomena of life and death, our author leaves the subject as it was before. True, he admits that life involves two essential conditions, destruction and renewal; and he does not attribute it, as some do, to a vital principle; but something more is to be expected from one in Mr. Savory's position. Nevertheless, those who are anxious to know something of the grand fundamental laws of physiology cannot do better than read these lectures.

THE STORY OF THE GUNS.†

WHAT is the condition of our national defences? This is the question which almost everybody puts to everybody, but which very few indeed are able to answer. Now, when we are almost on the eve of a general European war, it behoves us to inquire into the matter of armaments, to see in what way our homes and hearths are protected. This we can only do by making ourselves acquainted with guns and gunnery, and by thus being enabled to compare the merits of different varieties of the latter. The author of the present volume has spared us an infinite amount of labour, for he has compiled all the information which lay scattered here

* "On Life and Death." By WILLIAM SAVORY, F.R.S., &c. London: Smith & Elder. 1863.

† "The Story of the Guns." By Sir J. EMERSON TENNENT, K.C.S., LL.D., F.R.S. London: Longman & Co. 1864.

and there through newspapers, journals, reviews, blue-books, and such-like, on the subject of guns, and has formed a book which is as interesting as a novel, and as instructive as it need be. Sir Emerson Tennent has exhausted the entire history of guns, and by the mass of evidence which he has adduced, has taught us a great and serious lesson; one too which we trust may leave some permanent impression on the Government of this country. He has been accused of partiality. It has been asserted that the book before us is little better than an advocacy of Mr. Whitworth's views. We candidly confess we do not see that it is anything of the sort. It seems to us that the author has done ample justice to Sir William Armstrong, even while placing in their true light the discoveries of Mr. Whitworth. There can be very little doubt that the claims of the latter have been grossly neglected by those in power, and we congratulate Sir E. Tennent upon his able exposition of the case. It does not seem likely that in this century anything in the shape of a perfect gun will be discovered, and therefore the authorities are unwarranted in supporting the system of a single individual, and excluding all idea of competition. This is what our author teaches, and it is this open and independent expression of opinion which has given rise to the adverse criticism of some of our contemporaries. For our part we consider that the book will effect good service, and we cordially commend it to the consideration of everyone possessed of patriotism and independence. It is beautifully illustrated, and reflects much credit on its publishers.

HANDBOOK TO THE COTTON CULTIVATION IN MADRAS.*

THOSE anxious to know how cotton is cultivated in India, will find in this book a useful and well-selected compilation of the various modes of culture, and the conditions under which they occur, in Madras. The author does not profess to have had any experience in the matter, but admits that he has drawn on many different sources for materials. He has not produced a very light volume, though the latter from the arrangement of the letter-press will be found invaluable as a book of reference, a character which most probably it was intended to possess. The text is divided into a multitude of sections, each of which has its own special heading; and as the matter has been taken from various writings, side-notes are given, which contain the title and date of the works referred to. Mr. Wheeler has evidently been at considerable pains to produce a useful work, and we think the result has realized his anticipations. His conclusions as to the growth of cotton in India are as follows:—(1.) American cotton can be grown, but the profit is questionable. (2.) Indian cotton may be improved, but only to a degree. (3.) American cotton must always command a higher price than Indian. (4.) The demand for Indian cotton must always depend on the supply of American.

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* "Handbook to the Cotton Cultivation in the Madras Presidency," &c. By J. Talboys Wheeler. London: Virtue Brothers. 1863.

SCIENTIFIC SUMMARY.

AGRICULTURE.

Effect of Phosphate and Potass Manure on the Cultivation of the Potato.—Baron Liebig recently delivered a discourse before the Munich Academy of Sciences, on the subject of the cultivation of the potato crop. He alluded more especially to the experiments relative to the laws of the nutrition of plants which have been made under the auspices of the Institute of Physiology, by Professor Nœgeli and Dr. Zoëller. These experiments were thus carried out: Three fields were selected; in the first the soil consisted of plain powdered turf of Kolb; in the second, formed of the same soil, the ground was manured with ammoniacal salts, while the third whose soil was the same as that of the other two, was manured with the fixed elements, which constituted the ash of the tuber. An equal number of tubers was planted in each of the three fields. The field manured with ammoniacal salts produced more than the first, but the third, which had received phosphate of lime and potash, was the most fertile of the three. The results being represented by figures stood thus:—

1st Field	...	...	...	...	100
2nd do.	...	...	...	...	120
3rd do.	...	...	...	...	285

From these results it follows that the farmer may avoid the carriage of large masses of animal manure to his potato fields, by supplying a judicious mixture of phosphate of lime, gypsum, and wood-ashes. The different results of the three experiments can alone be attributed to the different compositions of the three soils, all other conditions having been identical. In the two first cases, there were absent those conditions necessary to produce in the subterraneous parts as many organic substances (tubers) as in the third; or in other words, to draw them from the atmosphere. Baron Liebig observes that these indications are not the most important results of the experiments alluded to. It was also found that all the potatoes drawn from those fields which did not possess the mineral ingredients in sufficient quantity, were attacked by the disease; and, after a few weeks, the decomposition had extended to the interior of the tubers. On the other hand, the tubers grown in the third field which had been manured with the mineral elements of the plant remained perfectly healthy, and none of them exhibited the slightest trace of the attacks of oïdium. It is therefore unquestionable that the conditions favourable to the normal development of plants are also those which tend to prevent disease, and that the first cause of the disastrous epidemic should be sought *in the soil*. If the latter

possesses in sufficient proportions the elements essential to the discharge of the proper functions of the plant, this in its turn will be enabled to resist and paralyze the injurious influences which tend to affect it externally. See report of Baron Liebig's discourse, in a pamphlet entitled—*Lettres adressées à la Gazette de Lausanne*, January, 1864.

Population and size of Inhabitants of a Country dependent upon the Character of the Soil, is in effect the title of a curious essay by the late Feu Jobard, of Brussels. As it bears closely upon the subject of land culture, we give a notice of it here. The author first shows that a very large quantity of phosphates is required in building up the skeletal portions of the animal fabric, and then maintains that in the event of a deficiency in the supply of this material, the animal (man) will not attain his full size. He writes, "Phosphoric acid is so essential to the well-being of plants, that lands which possess nitrogenous materials in abundance remain unfertile without phosphates. This is why Asia Minor, Sicily, Palestine, Arabia Felix, Rome, and the plains of Babylon are barren, because of the enormous quantity of phosphate drawn from them by their vast populations. This has occurred to all countries inhabited for a long period, with the exception of Egypt, but in the latter case, the numerous inundations bring down vast supplies of the phosphatic material from the regions of Upper Nubia. The reason why the size and number of inhabitants in Spain diminishes is, because of the want of phosphoric acid to give to the skeleton that development which was found among the ancient Gauls."—*Presse Scientifique des deux Mondes*, Vol. II., Nov. 22.

ASTRONOMY.

Exterior Envelope of the Sun.—Mr. Dawes considers that some of the so-called new discoveries on the sun's envelope are merely those which he himself described many years since. The large apertures and high powers now generally made use of give to the sun, when scrutinised under favourable atmospheric circumstances, an appearance so different from that presented by telescopes formerly in use, that it is not surprising that observers imagine they have made new discoveries. Mr. Dawes states that the mottled aspect of the sun can be seen with a good refractor of $2\frac{1}{2}$ inches aperture, and a power of 60. Examined with an aperture of 6 or 8 inches, he finds that the surface is made up of luminous masses imperfectly separated from each other by rows of minute dark dots, which are exceedingly close together, the intervals between them being less luminous than the general surface of the sun. The masses thus incompletely separated are of every variety of irregular form, those which are described by Mr. Nasmyth as "willow leaves," viz.—long, narrow, and pointed, being the rarest of all. These last are generally situated in the immediate vicinity of large spots, and even on the penumbræ. They sometimes project towards the spot itself, the edges of which appear ragged, "looking much like a piece of coarse thatching with straw, the edge of which has been left untrimmed." Mr. Dawes does not agree with Sir John Herschel that these minute dark dots or pores are in a constant

state of change. Having examined minutely very small portions of the sun's surface with very high powers of his solar eyepiece, he has been able to keep the same luminous masses and their intervening pores in sight for an hour or two together, and has rarely seen any decided change in either, though he has noticed that very slight atmospheric tremours will give such an appearance. In the immediate neighbourhood of spots which are rapidly enlarging or closing, this tranquillity, however, is no longer observed, and the luminous masses become more elongated. This change is the more remarkable in those cases where the spot is divided by a bridge which passes out from the penumbra, when the luminous masses take the appearance of bits of straw, and seem to be "preparing for a rush across the chasm." These bridges, he finds, are always formed by the bright streaks of the outer stratum. Mr. Dawes calls attention to the very dark spot frequently seen in the umbra, the former being the true nucleus, whilst the latter is improperly termed so. He finds that the pores are not quite round, but appear like fissures—not black, but of a dark grey. He has no doubt but that the bright faculæ are ridges, as he has seen them actually project beyond the limb of the sun, like the mountains at the edge of the moon. He is, however, of opinion that the less luminous masses do not mingle with the brighter ones, although they are on the whole at the same level. The *umbra* he considers to be a cloudy and imperfectly transparent cloudy stratum, the penumbra as self-luminous, making the second envelope, and the third envelope is the photosphere. The very deep spots, he thinks, are formed by an immense volume of non-inflammable gas from the surface of the sun, which latter he imagines to be the nucleus or darkest points of the umbra. The superficial spots are considered by him as convulsions in the photosphere itself.

With the large Greenwich refractor, Mr. Stone observes the sun's photosphere to have an appearance similar to that as if it were covered with grains of rice. It has been remarked that it is probable that the willow leaves of Mr. Nasmyth, the particles of straw of Mr. Dawes, and the above description of Mr. Stone, are one and the same phenomenon.

Comet of December 28, 1863.—This comet came very near the earth in the month of January; but it was not visible to the naked eye, although expected to be so. It is interesting, however, to know that it appears to be one of the periodical class; and it has been concluded to be identical with those of 1490 and 1810. If its suspected period of fifty-three years be correct, it should of course have appeared about the years 1543, 1596, 1649, 1703, and 1757; but its faintness on the present occasion, when it required a good telescope to perceive it, may account for its invisibility at those times. In 1490 it is described as having a very long and white tail, which was turned towards the east, and followed the sun after setting. It is described as having been visible from the feast of the Epiphany to the middle of February. The comet of 1810 was discovered on August 22 of that year by M. Pons, and was seen by him to October 8 of that year. It does not appear to have been visible to the naked eye on that occasion, and it is described as being round, with a faint nebulosity. The observations, both in 1490 and 1810, were rough and uncertain; but the identity of the two comets, as deduced from their similar paths and motions in space,

was even suspected in 1810, which its re-appearance on the present occasion strongly confirms. It was discovered in America on January 8 (independently), and the astronomers of that country are also of opinion that the three comets are identical.

Distance of the Moon.—Closely following on the improved knowledge of the distance of the sun comes that of the moon. The mean distance of our satellite was determined by Professor Adams as 238,793 miles, and this result has been generally adopted. From a laborious discussion of the lunar observations made contemporaneously at the Cape of Good Hope and various European observatories, Mr. Hugh Breen has determined that the above distance must be diminished by 26 miles. Mr. Breen's result has been adopted in the "Nautical Almanac" of 1867, and will doubtless be generally made use of by astronomers. It has thus been found that we are nearer both to the sun and moon than was formerly suspected; but the correction to the distance of the latter body is small in comparison with the four millions of miles by which we are found to be nearer to the former.

Variable Nebula in Taurus.—On a beautiful observing night on December 12, Mr. Hind looked for this curious object with the same telescope which he used on the night of its discovery (October 11, 1852). Not the least trace of it could be seen; but the star which almost touched it was equally perceptible as in 1852. Strange to say, this latter object is also variable. On the same night his assistant, Mr. Talmage, who could distinguish eleven stars in the Pleiades, was equally unsuccessful in detecting any nebulosity.

Nebula of Orion.—Mr. Stone examined this nebula with the Greenwich refractor on January 11, and is of opinion that the drawing by Sir J. Herschel is more accurate than that of Professor Bond, particularly about the so-called jaws. The drawing of Professor Bond gives a squareness of outline, and an almost total absence of light within the jaws, which is not seen by the Greenwich observers.

Supposed Lunar Atmosphere.—Professor Challis controverts the Astronomer Royal's argument in opposition to his theory explaining the presence of a bright band bordering the edge of the moon, as seen during a solar eclipse. The Astronomer-Royal, he states, takes the case of a mean atmosphere, whereas his explanation supposes the existence of one whose density decreases with its height.

Light of the Moon at Total Eclipse of June 1.—The Astronomer-Royal compared the light of several stars with that of the moon on the above occasion. Being short-sighted, the stars appear to him as large luminous discs, similar to the moon. He thus found that the moon's light exceeded that of Antares and Spica, somewhat exceeded that of Alpha Ophiuchi, and was a very little less than that of Alpha Aquilæ.

Star Maps.—The magnificent catalogue and star maps of Professor Argelander are now completed—the number of stars registered amounting to 324,198 altogether, which are visible in the northern hemisphere with a telescope of $4\frac{1}{2}$ foot focus. The preparation of this great work has taken upwards of seven years, in which there were 625 clear nights, and the number of observations amounted to more than a million. The month of

October was found to be best adapted for observations in the climate of Bonn.

Motion of Solar System in Space.—Mr. Stone, from a long discussion of the proper motions of stars, concludes that when those are large, there is numerical evidence that the solar system moves in space, but that this evidence is slight.

New Telescope.—Mr. Wray, of Upper Holloway, has constructed a telescope of eight inches aperture, and having only eight feet focal length. We had an opportunity of testing its powers on the night of March 12, and although the sky was not favourable, the separation of a double star of Struve, of 0″,67 distance was easily seen, and that of the double star following Procyon was very apparent. Its action on the moon was equally favourable, and its achromatism is perfect.

Parallax of Stars.—From Dr. Auwers' researches it appears that the star 61 Cygni is much nearer to the sun than at first supposed. Bessel found its parallax to be about $\frac{1}{3}$ of a second; M. Otto Struve upwards of half a second, whilst Dr. Auwers makes it 0″,56. He also finds that a star in Lalande's catalogue (No. 21,258) has a parallax of 0″,27, being at a distance of 761,000 times that of the sun, and the light of which would require some twelve years to reach the earth.

Nasmyth's Solar Discoveries.—Mr. Nasmyth claims to have been the first "to discover, delineate, and accurately describe" the structure and structural details of the sun's luminous surface, and those curious forms which he has termed the "willow leaves," with which this luminary is completely covered. He states that they are scattered in every direction over its surface—no symmetrical arrangement being perceived. He estimates their length at 1,000 miles, and their width about 100. The thickness of the layer of those luminous spots does not appear to be considerable, as the semi-luminous atmosphere on which they float can be perceived through the interstices, and which give to the sun its peculiar and well-known mottled appearance. The actual form of those singular bodies is best seen when they drift across a spot and form those "bridges" which occur when the spot is collapsing.

Recorded Darkness of the Sun.—Mr. Carrington quotes a passage from Bale's "Pageant of Popes" (1574) which states that in the time of Leo the Third (796–816), the sun was darkened and lost his light for eighteen days. This is not recorded by Humboldt.

Comets in 1863.—In all, six comets were discovered during the past year. Mr. Romberg states that the fourth comet, in December, appeared as an oblong nebula not brighter than a star of the eighth magnitude. The fifth, which was visible to the naked eye in November, when it shone as a fifth-magnitude star, was not more than of the seventh magnitude in December. A tail was seen on both occasions, at the latter time very faint.

Catalogue of Nebulæ.—A valuable work, containing all of Sir W. Herschel's nebulæ (2,500 in number), with other catalogues, and comparisons between them, has been published by M. Auwers. The want of such a work has long been felt by such observers as were engaged in searching for comets, as no complete catalogue existed previously.

Ancient Chinese Eclipses.—Mr. Williams has drawn up an interesting account of thirty-six ancient eclipses, recorded in the Chinese annals, commencing with one 720 B.C. and ending with that 495 B.C. He is of opinion that they were possibly observed in the state of Loo. They will serve, as Mr. Williams hopes, to test the accuracy of Chinese history.

Photographs of the Moon.—Mr. De la Rue is now engaged in amplifying his original and small photographs of the moon to the size of Maedler's great map of thirty-eight inches in diameter, and the results obtained are extremely satisfactory.

BOTANY.

A Species of St. Johnswort new to Britain.—This has been discovered by Mr. T. R. Archer Briggs, and a notice of the plant appears in "The Journal of Botany" for February. It has been identified with *Hypericum undulatum*, which though widely distributed over Southern Europe, Northern Africa, Madeira, and the Azores, has not before been observed in England. Mr. Briggs first collected the plant in August, 1861. It grows in great quantities upon a small stream which flows into the Plym, and in two or three other localities within a radius of about six miles. The stem is more or less quadrangular, and reaches a height of from two to three feet; the leaves which are oblong and embracing, are covered with transparent dots and a network of pellucid vessels. The inflorescence is a corymbose pannicle; the sepals are always erect, and the petals which are of an obovate form are tinged with red on the outside. Like its kindred it affects a boggy soil.

The Common Ling, an American Plant.—That *Calluna vulgaris* is really as much a native of the New World as of the Old would appear from Mr. Hewett C. Watson's examination of plants purchased by him at the Linnean Society's sale in November last. The occurrence of this plant in Massachusetts, U.S., was recorded in 1861, by Professor Asa Gray. Since, however, the latter botanist expressed his opinion that it might have been introduced, the matter remained for some time in an unsatisfactory state of uncertainty. It is now a settled fact that the Common Ling, or some plant identical with it, is really an American species. Amongst Mr. Watson's purchases was a parcel bearing the label "A collection of dried plants made by — McCormack, Esq., and presented to Mr. David Don," and within this bundle were specimens of *Calluna vulgaris*, which unfortunately were devoid of flowers, but which bore a label stating that they were found at the "Head of St. Mary's Bay, Trepassey Bay also very abundant, S.E. of Newfoundland, considerable tracts of it." The plants thus labelled exactly resembled the Common Ling, and although Mr. Durand suggests that the American plant is a larger flowered species than ours, there seems good reason for believing that such is not the case. Vide *Natural History Review* for January, and *Journal of Botany* for February.

Arrangement of the Salix Species.—This complex and puzzling group of plants, which has produced so many controversies among our most distinguished botanists, has at last been systematized scientifically. The task was undertaken by Dr. Andersson, of Stockholm, who was certainly well

adapted to such a laborious undertaking. He bases his classification upon certain characters of the male and female floral organs; thus we find the groups *Monandræ*, *Diandræ*, and *Polyandræ*. The Diandræ are further divided into sub-groups characterized by peculiarities of the female portions of the flower. Dr. Andersson's memoir has, we believe, been presented to the Royal Academy of Stockholm.

"*Struggle for Life*" *among Plants*.—That Mr. Darwin's views in regard to the mode in which one type of animals replaces another are now generally accepted, is, we believe, well known to all our readers. That his opinions on this subject are equally applicable to plants has been shown by Dr. Hooker, in a late memoir. In treating of the mode in which this substitution occurs, the author alludes more particularly to the spread of European plants in New Zealand, and gives the following most interesting quotation from the writings of a correspondent:—"You would be surprised at the rapid spread of European and other plants in this country. All along the sides of the main lines of road through the plains, a *polygonum* called Cow-grass, grows most luxuriantly, the roots sometimes two feet in depth, and the plants spreading over an area from four to five feet in diameter. The Dock is to be found in every river-bed * * * * * The Sow thistle is spread all over the country, growing luxuriantly nearly up to 6,000 feet. The water-cress increases in our still rivers to such an extent as to threaten to choke them altogether. * * * * I have measured stems *twelve feet long and three-quarters of an inch in diameter*. In some of the mountain districts where the soil is loose, the white clover is completely displacing the native grasses, forming a close sward. * * * In fact, the young native vegetation seems to shrink from competition with these more vigorous intruders." It appears to be a saying among the native population of New Zealand that, *as the white man's rat has driven away the native rat, so the European fly drives away our own, and the clover kills our fern, so will the Maoris disappear before the white man himself*.—*Natural History Review*, No. xiii. p. 123.

Peculiar Form of Asplenium Ruta-muraria.—In May last, Mr. F. J. Foot communicated to the Natural History Society of Dublin a short paper, descriptive of a new variety of this handsome fern. The specimen laid before the society was unquestionably the *A. ruta-muraria*, but considerably modified, the upper pinnules resembling both in form and texture those of *A. germanicum*. The variation is more remarkable, from the circumstance that there appeared to be no external influence adequate to explain the alteration of specific characters.

What is Palmógloea macrococca?—An attempt to solve this very difficult query has been made by that indefatigable microscopist, Mr. Wm. Archer. The paper in which the solution of the difficulty is essayed is accompanied by a beautifully-executed plate, delineating the characters and development of *Mesotœnium chlamydosporum*, which Mr. Archer believes the above-named plant to be identical with. The original memoir, which is of considerable length, and may be almost regarded as a *resumé* of what is known upon the subject, should be consulted by those interested in microscopic botany.—Vide *Dublin Quarterly Journal of Science*, Jan. 1864.

Growth of Peruvian Cotton in India.—Mr. Clements Markham has

conducted an extensive series of experiments with cotton plants, introduced into Madras from the valleys of the Peruvian coast. He believes that if this form is cultivated on the sand-flats and drifts forming the sea-board to the north of Madras, the result will be commercially satisfactory. In his opinion the cotton should be grown with cereals, in order to enable the grower to pay the existing land-tax. The results adduced in support of his views would not, however, appear to us to warrant the conclusion at which Mr. Markham has arrived.—See *Journal of Botany*, No. xiii. p. 9.

Influence of Smoke on Vegetation.—In a paper read before the Royal Society, partly on the above subject, Professor Voelcker states that he has had many opportunities of becoming practically conversant with the injurious effects which a smoky atmosphere produces on cereal crops, and that he regards a strong deposition of soot on wheat and other corn crops quite a sufficient evidence of the more or less complete injury which the crops must have suffered from the sulphurous acid always present in the air when such sooty deposits are seen on plants. The disadvantages of carrying on agricultural pursuits in the Potteries, or in districts where volumes of black smoke discharge enormous quantities of sulphurous acid into the air, are well known amongst the more intelligent and enterprising farmers. The injury done to vegetation by the smoke from copper works has been traced beyond a distance of four miles. Of course it might be asserted that the mischief was caused by the arsenical vapours; but the latter are present in almost inappreciably small quantities, whilst as small an atmospheric per-centage of sulphurous acid as the $\frac{1}{800000}$ is injurious to vegetation in wet weather. The fumes arising from brick kilns may be said to be equally destructive of growing plants.

Distribution of Raphides.—Professor Gulliver appears to be almost indefatigable in the pursuit of this subject. He seems even now, more than hitherto, to regard the presence of raphides as a sufficient character on which to depend in the identification of certain plants, and refutes the objections of his opponents by stating that the existence or non-existence of crystals in the soil does not appear to influence the plant, to any great extent, in regard to its possession of raphides. In speaking of the liliaceæ, some of which do, and others of which do not, present raphides, he observes: "Such an irregular distribution of raphides in the members of one order might lead us to suppose that the fact must be connected either with seasons, climate, or soil, which I believe is not entirely the case; because in some (though not all) of the species mentioned, the constancy of the results was verified under many such conditions. Several of the plants were examined more than once from various localities, and during different seasons and years; while *Allium ursinum* and *Ornithogalum umbellatum* were particularly made the subjects of repeated and protracted observations, and always with the same results of no raphides in the former, and an abundance of them in the latter species." In support of Professor Gulliver's view, it may also be mentioned, that such plants as the willow-herbs, which are essentially raphidiferous, may always be found with an abundance of raphides. The onion has formerly been given as an illustration of a raphidiferous plant, but Professor Gulliver has shown that

the crystals which it contains are not true raphides.—Vide *Magazine of Natural History*, January.

The Kilkee Fucus.—It would appear that this is no longer to be styled *F. distichus*. The following is sufficient reason for this statement:—"Notwithstanding all that has been said *pro* and *con*. I have now to inform you that the Kilkee fucus is neither *F. distichus*, nor yet *F. fuscatus*, nor yet any species known to Professor Agardh, from whom I have just received a specimen of the true *F. distichus* of the elder Agardh; and so being constrained to give it a name, I propose to call it *Fucus anceps*, Ward and Harvey; and I request you to make known this *alias* to all to whom you have (on my authority) given the wrong name. This Fucus seems to combine the characters of the ribbed and ribless species, and therefore it may with propriety be named *F. anceps*" (Letter from Professor J. H. Harvey to Dr. J. E. Gray).—See *Annals of Natural History* for February, 1864.

Respiration of Plants.—M. Felix de Faucoupret follows in the suite of M. Corenwinder and others, and gives us the annexed conclusions as the only ones to be drawn from the investigations which he has made:—(1) The quantity of carbonic acid absorbed or exhaled by the same plant varies with the temperature, the mode of respiration remaining the same. (2) At the same temperature, the quantity of carbonic acid absorbed or exhaled varies according to the nature of the plant. (3) The law explaining the relation of the quantities to the different temperatures is expressed by a parabolic formula, no matter what be the mode of respiration, or the family to which the plant belongs. (4) The coefficient of the square of the temperature is constant for all plants whose temperature is the same. (5) This coefficient varies for the same plant according to the mode of respiration. It will, no doubt, be interesting to our readers to see that even so essentially inductive a science as botany may be found possessing mathematical laws, such as those above stated.—Vide *Comptes Rendus*, February 15th.

Spontaneous Generation.—We have much pleasure in stating that there is at last a prospect of the question of *equivocal generation* being settled. We learn, from the *Comptes Rendus*, that the Academy has appointed a commission to inquire into the evidence on both sides, and that M. Pasteur and Messrs. Pouchet, Joly, and Musset have been invited to repeat their experiments in the presence of the commissioners. The invitation has been accepted by both parties, the advocates of spontaneous generation appearing to be quite sanguine of success, and reposing the most perfect confidence in the impartiality of the commission.—See *Comptes Rendus*, January 25th.

CHEMISTRY.

Spectral Ray of Thallium Paralysed by that of Sodium.—It appears that if thallium be present in small proportions in a compound containing chloride of sodium, the action of the ray characteristic of the latter is so powerful that the thallic ray remains unperceived. Hence, although the thallic ray be not observed in the solar spectrum, it by no means follows

that the metal itself does not exist in the sun. This is a fact of great importance, not only in regard to ordinary chemistry, but as it bears on toxicology. For in an analysis (spectral) of the animal tissues or liquids, one is certain to find chloride of sodium in abundance, and therefore, were thallium present in small proportions, it would escape detection by this method. If it be required to examine mineral waters and such-like for thallium, it will be necessary to separate the metal in the first instance from the excess of soda; this may be done by one of the methods pointed out by M. Lamy; viz., either by depositing it on zinc, or reducing it by galvanic means, or by precipitating it with sulphide of ammonium or iodide of potassium.—See a memoir by M. Nicklès in the *Comptes Rendus* for January, 1864.

Soap for very Dirty Hands.—The following is a novel German receipt for the manufacture of a soap whose cleansing properties are said to be of a high order:—Two pounds of finely rubbed carbonate of magnesia are to be mixed in a porcelain dish, with eight pounds of waterglass and eight pounds of water. To these, four pounds of oleic acid are added, and the whole is gently warmed and stirred as long as carbonic acid is evolved. Lastly, a pound of crystallized carbonate of soda dissolved in some warm water is added, and the mass is dried, and made into shapes.—*Vide Chemical News*, January 3rd, 1864, and *Chemisches Centralblatt*, No. liv., 1863.

Non-existence of Pyro and Meta-Arseniates.—The currently received opinion that the phosphates and arseniates are analogous compounds has been refuted by M. Maumené. In a memoir laid before the French Academy in the beginning of February last, he asserts most positively that neither of the compounds above referred to has any real existence. It was thought by Pelouze that the arseniates, like the phosphates, were modified by heat and converted into salts having other proportions of base and acid. M. Maumené states that "it is nothing of the kind; arseniate of soda never gives either pyso-arseniate or meta-arseniate. Submitted to an intense heat violently or carefully, or for a lengthened period, it does not undergo the slightest alteration of the sort imagined. Dissolved in water, and then mixed with a silver solution it invariably gives the brick-red arseniate As, O_5, 3, Ag, O. Arseniate of soda was kept at a red heat for several days, and its properties remained unaltered, and when added to solution of nitrate of silver the brick-red arseniate was produced; a similar result was obtained by employing the acetate instead of the nitrate of silver. Arseniate of potash was obtained from acid prepared by Gay-Lussac's method, and heated to redness with the same results as when the soda salt was experimented on. Finally, M. Maumené treated the arseniates of baryta and lead in a similar manner, and produced a silver-precipitate like that which the soda salt gave rise to, thus affording conclusive proof of his assertion that the modified arseniates do not really exist.

The Decomposition of Iodide of Mercury.—This may readily be effected by employing the cyanide of potassium. In order to estimate the proportion of mercury in the iodide the following method may be employed. The evanide of potassium is first rubbed down in a mortar, with twice its weight of quicklime. Then a tube, closed at one end, is taken, and a small

quantity of carbonate of magnesia is placed in it. The iodide is now mixed with eight times its weight of cyanide of potassium, and introduced into the tube; next, a layer of the mixture of cyanide and lime is added; and, finally, the upper part is covered with carbonate of magnesia. The tube is drawn out in the usual manner, and made to dip into water, when, heat being applied, the mercury distils over. Of the other means which may be employed in the decomposition of iodide of mercury, we may mention those of metallic zinc and protochloride of tin; the former completely decomposes the iodide, the iodine combining with the zinc; the latter also reduces the metal, but rather incompletely.—*Poggendorff's Annalen*, chap. xviii., and *Chemical News*, February 27th.

A New Form of Gunpowder has been devised by Messrs. Hall and Wells, of Worcester. It consists of 47 parts of chlorate of potash, 38 parts of ferro-cyanide of potassum, and 5 parts of sulphur. The ingredients are first separately reduced to powder by grinding upon suitable slabs, then they are mixed together, water being used till they form a sort of paste. When the mixture has become dry, about ten parts of caoutchouc are added. The compound is then complete. One of its advantages is, that it may be so moulded that the entire charge shall constitute a solid mass, thus affording great facilities to the manufacture of cartridges.

The Proportion of Ether in Brandy and Vinegar.—Mr. Berthelot, who has already estimated the percentage of ether in wine, now gives his attention to the substances which are derived from wines, or their principles; to brandy, which is obtained by distillation; and vinegar, which is a product of oxydation. Brandy contains the following materials:—

1. Water.
2. Ordinary alcohol, and some traces of Amylic, and other alcohols.
3. Some of the volatile acids of wine (acetic, Butyric succinic ? &c.), traces of which only present themselves in ordinary wine, and most which remain in the case of brandy, in the undistilled residue. Besides these, there are empyreumatic acids in small proportions.
4. The more volatile ether of wine (Acetic, Formic ?). The proportion of these in wines is small, and distillation is too rapid to alter them to any great extent.
5. Various volatile principles proceeding from the wine, or from the fermented liquor; such, for example, as the essential oils, aldehydes, &c., empyreumatic products, and certain substances abstracted from the casks.

In the preparation of vinegar, a large quantity of the alcohol is converted into acetic acid, and another portion is completely oxydised. If all the alcohol disappears no ethers will be found; generally speaking, however, there remain slight traces of alcohol, and consequently of ethers also, whether these ethers pre-existed in the wine, or were developed at the moment of oxydation by the influence of nascent acetic acid, or at a later period by reason of the liquid being kept by for a long while. These ethers consist chiefly of the acetic form, because the acid of this series predominates. There can be no doubt that ethers give much of their

bouquet to wine vinegars, whatever be their origin.—Vide *Comptes Rendus*, lviii., No. 1.

Is Oxygen a Tetra-atomic Element?—This question would appear to be answered in the affirmative by M. Naquet, who conceives that he has established the tetra-atomic character of sulphur and selenium. In his opinion, the tetra-atomicity of the latter bodies being established, if we consider the many analogies which exist between sulphur and oxygen, and also the fact that the atomicity of a body may vary with the radical which it enters into combination with, as in the case of lead which is tetra-atomic with ethyl, and bi-atomic with chlorine, we are justified in supposing that oxygen belongs to the sulphur, selenium, and tellurium family.—*Comptes Rendus*, February 22nd, 1864.

Action of Fungi on Solutions of Cane Sugar.—Under this heading, a valuable memoir was some time ago communicated to the French Academy by M. Béchamp. He points out a curious fact presented by a sugary solution which had been mixed with oxalate of potass, and which contained some fungous growths. The liquid was alkaline, but when treated with an acid it gave off carbonic acid. Hence it may be concluded, that under the influence of these plants the oxygen had decomposed the oxalic acid, and the sugar was transformed into glucose in an alkaline solution.—*Comptes Rendus*, Feb. 15th.

Valerylene, a new Homologue of Acetylene, is the name given to a compound discovered by M. Reboul. It is obtained by heating for some hours to 140° (centigrade), and in closed tubes brome-amylene, with a saturated alcoholic solution of potass. When water is added to the product, a substance is separated, which consists of a mixture of valerylene alcohol and brome-amylene. The new compound may be separated from the alcohol by agitation with cold water, and from the amylene compound by distillation at a low temperature. It is very volatile, and is not absorbed by the ammoniacal solution of sulphate of copper, although allowed to remain in contact with it for several days; it is a colourless liquid less dense than water, in which it is almost insoluble, and has a peculiarly garlicky odour. It distils over at from 44 to 46° centigrade. Its formula is C_{10} H_8. Analysis gives it a composition of 87·31 of carbon, and 12·04 of hydrogen. It combines most energetically with bromine; so much so that in allowing the combination to take place every precaution must be observed to keep the fluid at a temperature close on 32° Fahrenheit.—*Comptes Rendus*, January 25.

Purification of Oxalic Acid.—The ordinary method consists in the successive crystallization of the commercial acid in distilled water. M. Maumené finds this process to be rather a means of rendering impure than of purifying the acid. He discovers a greater proportion of alkali in the crystals last obtained, than in those of the first series. He therefore recommends the following process as the one best adapted to the object in view:—Dissolve the ordinary acid in sufficient water to give from ten or twenty to a hundred crystals, according to the degree of impurity. Let these crystals be laid aside. Next, evaporate the mother liquor, and submit the crystals resulting from it to two or three successive crystallizations,

and an acid free from alkaline oxalates will be produced.—Memoir presented to the French Academy, January, 1864.

Chemistry of the Oil of Nutmeg.—The nutmeg owes its peculiar aromatic properties and flavour to a volatile oil which is present in large quantities, but up to this it has not been submitted to a chemical examination. This oil may be extracted by boiling the kernel in an ordinary retort, but in this process only a portion of the essence is obtained. A preferable method appears to be the treatment of the finely-powdered nutmeg with bisulphide of carbon or sulphuric acid. The mixture is then filtered, and a stream of vapour is caused to play upon the residue, which then loses all the essence it contained. The composition of the essence obtained in this manner is the same as that of volatile oil of turpentine. When exposed to the action of the air, it absorbs oxygen slowly and loses its fluidity. It is rapidly attacked by chlorine, giving off at the same time fumes of hydrochloric acid, and is transformed into a chlorinous compound of a viscid, non-crystallizable nature. Bromine affects it in a similar manner. It is slightly soluble in water, and perfectly so in absolute alcohol. A mixture of this essence, alcohol and nitric acid, when kept for some months, gave rise to no hydrate; this is the first chemical character which distinguishes this substance from volatile oil of turpentine. Nitric acid reacts upon it powerfully, causing fumes to be given off, and producing oxalate of ammonia and several other compounds. It is soluble in concentrated sulphuric acid, to which it gives a brown colour, sulphurous acid being disengaged. The action of hydrochloric acid on this compound differs from that on volatile oil of turpentine, in the production of a *liquid* and not a solid hydrochlorate. Its formula may be represented as C_{20} H_{16}.—See a paper by M. Cloez, in *Comptes Rendus*, lviii. No. 2.

Composition of the Thermal Waters of Wildbad-Gastein.—Herr Ullick has informed the Vienna Academy of Sciences that he has determined the proportion of *lithium* contained in the waters of the above-named locality, and that he has also found in them traces of titanic acid, rubidium, and a comparatively large proportion of cæsium.—*L'Institut*, No. 1,565.

Isomeric Forms of Titanic Acid.—In a paper read before a recent meeting of the Academy of Sciences, in Berlin, Herr Rudolph Weber stated that the difference which existed between the hydrated titanic acid obtained by precipitating with alkalis and acid solution of this substance, and that obtained by the ebullition of a dilute solution of titanic acid, led him to believe that there existed two analogous and isomeric forms of titanic acid; to the first he gave the term of titanic, and to the second that of meta-titanic acid. These two compounds may be distinguished by the circumstance that the first is very soluble, and the second sparingly soluble in acids. Besides, the meta-titanic acid is precipitated from its solution in sulphuric acid by hydrochloric, whilst the titanic is not thrown down under similar conditions.

Blowpipe Reaction of Copper.—Dr. Gerland mentions in an article in the *Chemical News* of February 13th, that the appearance of the bead produced by the influence of the blowpipe flame on copper has not been accurately described. After long practice he has so far succeeded in the management of the blowpipe flame produced by a gas jet, as to have it

sufficiently under his control to use it for all purposes of qualitative and quantitative blowpipe analysis; but he has been unable to obtain the red opaque copper bead on the eye of a platinum wire in the deoxidising flame. The bead thus produced shows the characteristics of glass, coloured by protoxide of copper. When removed out of the inner flame, the bead is perfectly colourless and transparent, and remains so after cooling; but when again gently heated by holding it close to the flame, a beautiful ruby red diffuses itself through the glass without disturbing its transparency. This colour is not affected by cooling, but disappears by exposure to a stronger heat, and does not return on cooling. It can, however, be reproduced by a low heat as in the first instance. The changes are best observed when the end of the platinum wire is made rather wide, and not too much borax used, so that the head becomes elongated. If a little copper is dissolved in the flux, the glass is rendered colourless in the deoxydising flame, and if now one end of the bead is brought near the flame, this half turns ruby red, whilst the other half is left too cold to take the colour; but the first half when left for a moment in the exterior flame, becomes colourless by over-heating, and at the same time the other end is heated sufficiently to redden in its turn. The reader should consult the article itself for much that is interesting in regard to the subject it treats on.

GEOLOGY AND PALÆONTOLOGY.

Newly-discovered Bone Cave.—In making certain excavations in the rock of Gibraltar, the engineers have come upon a very extensive cavern containing the bones of numerous extinct mammalia and of man. From what we have already heard, this grotto bids fair to throw more light upon the question of the age of pre-historic man than any hitherto examined. As yet we have had no minute description of the fossils discovered in this locality, but we have been informed that a very great number of specimens has been forwarded to this country by one of the Gibraltar authorities particularly interested in the geology of the excavation.

Experimental Researches upon the Granites of Ireland is the subject of a paper lately presented to the Geological Society by the Rev. Samuel Haughton, F.R.S. The mineral constitution of the fifteen classes of granitic rocks was discussed in detail. Professor Haughton concludes from his investigations that nearly half of these granites are not composed altogether of the four minerals—quartz, ortho-classe, oligo-classe, and black mica—which are found in them in distinct crystals; and that the remaining varieties, even if they be composed of these minerals, must have a paste composed of the same minerals, but with a slightly different composition. The writer then treated of the composition of the syenites of Donegal, and instituted a comparison between the granites of that district and those of Scotland and Sweden, remarking that those of the last-named country have the same stratified structure as the granites of Donegal.—Vide the *Geologist* for February.

Sandstone Hammer in a Diluvial Deposit.—In a letter to the editor of

the *Geologist*, Mr. J. D. Sainter gives a description of an instrument of this kind which was found near Seddington, in a boggy soil, at a depth of about two yards from the surface. Its length was 7½ inches, and the hole for the handle measured about 1⅜ of an inch. One end was rounded, the other vertically wedge-shaped; and it is of superior workmanship, having been probably made at the close of the stone period. The specimen is of some local interest, but of course adds nothing in the shape of evidence to the support of the conclusions formed by geologists.

Fragments of Human Jaws found in the Cave of Bruniquel.—In this cavern M. Garrigou states (see his memoir in the *Comptes Rendus*, t. lvii. No. 25), that he has found not only the bones alluded to above, but also those of a reindeer, an antelope, a chamois, a large species of ox, a wolf, a dog, a fox, a smaller species of carnivore than the latter, two rasorial birds, a bird of huge size, and two species of fishes. Perhaps the most interesting feature in these researches was the discovery of "the humerus of an immense bird, upon which was rudely sculptured various portions of a fish's body." On one part was seen an engraving of a forked tail, and beside it two representations of a fish's head, and on another was sculptured three paddles or fins. M. Garrigou asks, "What conclusion are we to arrive at with regard to such a specimen, unless we look upon it as an amulet or some ornament of distinction?" The two jaw-bones were discovered in the presence of ten witnesses, at a depth of about two metres, in a bed of shale, containing particles of charcoal in large quantities, flint weapons, and ruminant bones. This bed supported a second of the same kind, but without charcoal, both being covered in by the osseous brecchia and stalagmite. The blow of the pick which turned up the first jaw *smashed the condyle, and drove out a number of teeth, which could not be found afterwards (!)* the first permanent molar, however, remains. The bone was that of an adult. If true, this discovery is even stranger than that made at Moulin-Quignon.

Pachyderms of the Paris Basin.—M. Watelet has discovered a stratum of the Paris basin, which contains fossil bones of an enormous size. The bones have been found at Jouy, near Aisne, and belong to the genus Lophiodon or Tapirotherium, of which M. Watelet believes that he has found remnants of the following species:—*L. occitanicum*, *L. isselense*, *L. tapiroïdes*, *L. Buxovillanum*, *L. giganteum*, *L. aurelianense*, and some others.

Mammalian Bones and Flint Implements at Audley-end, Essex.—In making certain cuttings in the neighbourhood of the river Cam, in order to divert the stream into another bed, a portion of meadow land, cut through to a depth of twenty feet by sixty, yielded two *cart-loads* of bones, which were employed by the barbarians of the neighbourhood in the manufacture of manure. So Mr. G. E. Roberts informed his audience at a late meeting of the Anthropological Society. Some of Mr. Roberts' descriptions of the conditions of these bones are of much interest. He describes many of the markings which appear upon them as being produced by sawing; others seem to have been produced by the action of some rude wedge or chisel. He supposes that all the markings exhibited were produced by flint implements, and observes,—"I am supported in my belief that these incised markings and scrapings were made by an edge

of flint, by Mr. Christy, who has studied these bones long and carefully. He detects, in the delicate ribs left upon the surfacing of the scoring by a flint edge, the peculiar curve in the direction which corresponds with the curved outline of the edge, and which he has found existing in all cuts and sawings made upon bone by implements of flint."

Marine Fossils of the Coal Measures.—It would appear, from a communication not long since made by Professor Roëmer to the Rhenish Natural History Society, that the marine shell strata found in the coal beds present a constant level. He has been investigating those of the coal mines of Upper Silesia, and he has found species of the genera *Bellerophon, Orthis, Productus, Orthoceras, Goniatites*, &c., associated with iron nodules. These fossils lay in shaly seams, at a height of about 100 feet above the valuable coal-beds. This relation may be said to be true for all coal formations.

Flint Weapons in the Grotto of Laroque.—The cavern of Laroque, situate on the route of Montpellier, between the former locality and Saint-Bauzille, has been explored by M. Boutin, who, in a note to the French Academy, describes the results of his investigations. He found in this cavern, bones, charcoal cinders, and prepared flints. The latter were of different sizes: some of them were not more than two centimetres long and two or three millimetres wide; they were pointed at each end. Others, of a larger size, were sharpened at one extremity only. Besides these, there were found rounded or lenticular pieces of flint, whose use it would be impossible to conjecture. M. Boutin concludes by observing,—"There is no doubt that many of our neighbouring caverns contain similar indications of the passage of man. And as in some of them I have already discovered considerable quantities of the remains of *Ursus spelæus*, I do not despair of one day finding both remnants associated."—*Comptes Rendus*, Jan. 4.

The Alluvials in the Neighbourhood of Toul.—In a memoir presented to the Academy by M. Husson the following general conclusions are drawn, relative to the geological bearing of the deposits above-named:—The country round Toul is of a character to throw a great deal of light upon the subject of the antiquity of man. The valley of the Ingressin possesses (1) an entire and undisturbed bed of Scandinavian *diluvial* nature, and a local *alluvial* one of the same date; (2) a very extensive deposit of Alpine diluvium, rich in fossils, and which has been worked for twenty years, to an extent of about eight kilometres. The valley of the Moselle exhibits (1) the same Alpine diluvium covering the plain of La Treiche; and (2) all the other elements for the study of the question alluded to; viz., peculiar caverns, human osseous brecchia, specimens of pottery and primitive human ornaments, groved bones of the same period, and very large flint weapons, like those of the Somme valley. An examination of all these deposits demonstrates,—1st, That all these remnants of primitive industry and of man, from whom they came, are of post-diluvian date. 2nd, In regard to the state of these alluvians and more recent strata, there are many sources of error, which are with difficulty perceived.—*Comptes Rendus*, Feb. 8.

Foramenifera of the Tertiary Basin of Vienna.—At a comparatively recent meeting of the Vienna Academy of Sciences, Herr Karrer communicated the results of his investigations into the character of the forameni-

fera, which had been deposited in the brackish-water shales of the locality referred to above. The foramenifera of these deposits constitute a special fauna, and are by no means of secondary origin, that is to say, elevated from marine beds, and then re-deposited by means of secondary currents of water. Although less abundant (specifically?) and striking than their kindred of the salt-water formations, they are nevertheless remarkable for the number of individuals presented. The same genera, and nearly the same species, which compose the true marine fauna, are found in the beds in question, but they are reduced to their minimum size, although the characteristic genera (*Nonionina*, *Polystomella*, *Rosalina*), belong to families the structure of whose shell is most complex. On the whole, this fauna is analogous in many respects with that of the Nullipore-marls. It is parallel with that of the Molluscan fauna of the same origin, and hence it may elucidate the nature of certain deposits in which the latter should be present, but owing to peculiar circumstances is absent.—Vide *L'Institut*, No. 1,565.

How Granite was formed.—In delivering one of the lectures of the Swiney course at the Royal School of Mines, Dr. Percy objected to the assertion of geologists, that granitic rocks must have been formed by plutonic agencies, for, said he, there are certain difficulties which have always been in the way of accepting this view of the subject—difficulties, known at all events to those who have been accustomed to make experiments on the fusion of mineral substances at high temperatures. This is especially seen by examining the condition of quartz in granite; it is always found in the crystalline condition, and has invariably a specific gravity of 2·6. There is not a single instance known to the contrary. Hence there is reason to believe that the quartz could never have been fused, for the moment silica is fused, no matter in what condition it was previously, a peculiar glass-like colloidal mass is produced, having a specific gravity which never exceeds 2·3. Therefore there is good reason to conclude that granite could never have been found under the condition of a high temperature.

Help to the Identification of Fossil Bivalve Shells.—Under this title we find an article in the February number of the *Geologist*, but we really are at a loss to see in what way the writer (Mr. H. Seely) has done anything to lessen the difficulties which the student encounters. He proposes the adoption of a series of formulæ as he terms them. These are really hieroglypics significant of the relations of the teeth, cartilage pits, sinuses, &c. We do not think it likely that his scheme will be approved of, and must refer the reader for further information to the contribution itself.

Geological Views of Local Savans.—It is much to be regretted that local scientific societies do not exercise sufficient precaution in regard to the previous examination of papers read before their members. A lamentable instance of what pseudo-scientific study may reduce a certain class of mind to, was exhibited at a late meeting of the Manchester Geological Society. A Mr. Dickinson, whose geological conceptions appear to rival even those of the celebrated Mr. Scattergood in regard to the laws of optics, communicated his opinions on the subject of "Modern and Scriptural Geology." The learned author, after annihilating the more leading

doctrines of geologic science, proceeded to observe, "Again, if the theory of sedimentary rocks were admitted, deposits would all be mixed; limestone, chalk, salt, and other such deposits, would never have been found in immense beds. There were no remains of surfaces like that which now covered the earth; no beds of rivers; and as to the so-called denudation, rocks thousands of feet—nay, even miles in depth, would be wanting to account for the present surface formations. Immense blocks of the denuded rocks would have remained. The pebbles and boulders were insufficient to account for what had disappeared. These pebbles were not drifted by glaciers, but were formed on the spot. Scripture told us that every plant of the field and herb of the earth was in the earth before it grew, and *this would account for fossil remains in whatever part of the structure of the earth they might be found.* The fossil remains of shells were numerous, because 'the waters brought forth abundantly;' but the winged fowls which were created on the fifth day seemed to have escaped, because they were made so that they might fly." It would be idle to quote any further. We may well say to our readers, *Verbum sapientibus.*

Coal Measures in Brazil.—At a late meeting of a local society, it was stated that a coal field had been recently discovered in the south of Brazil, which in some parts measured sixty-five feet in thickness. Two smaller ones lie to the north of it—one, said to be very valuable, in the province of Rio Grande do Sul, and the other in San Catherina. The field runs from south to north in one line of deposit, and appears to be oolitic. Coal had never before been found in this country, and of course the discovery will prove of immense value to the Government, which has hitherto been obliged to import this mineral at a great expense.—See *The Mining and Smelting Magazine* for January.

Scriptural Mention of Flint Weapons.—The Rev. G. N. Smith mentions in a letter to Mr. Mackie, that there occurs in the Septuagint a passage in Joshua which relates to the burial of certain flint implements. He indicates the possibility of explaining the presence of these weapons in tumuli, by reference to the Old Testament evidence, which is as follows (Joshua xxiv. 30)—"And they buried Joshua in the border of his inheritance, and they placed with him, in his tomb, the flint knives with which he had circumcised the children of Israel; and there they are unto this day."—Vide *The Geologist*, No. 74.

New Species of Hyæna from the Suffolk Crag.—The credit of discovering the remnant of a new being of Hyænoid type is due to Mr. E. Ray Lankester, who publishes his description of the fossil in a late number of the "Annals of Natural History." The only portion of the creature found was a tooth; this was discovered in the red crag at Felixstowe, in Suffolk, and from it alone Mr. Lankester has been enabled to establish an entirely new species. Dr. Falconer, to whom the specimen was submitted for examination, expresses, with some reserve, his opinion that the tooth belonged to an animal related to both *Hyæna spelea* and *H. crocuta.* From a comparison of the tooth (a third pre-molar) with the corresponding teeth of the other species, Mr. Lankester supposes that it is that of a new species, and remarks, "There appears to be no description of any species of *Hyæna* corresponding with the characters of this tooth, the specimens from

the older continental beds being, as far as I am able to judge, very different, if M. de Blainville's memoir may be relied on. I, therefore, for the sake of perspicuity and convenience, propose to call this species *Hyœna antiqua* provisionally. If at any time, further material should identify it with any known species, my name must be rescinded."—Vide *Annals of Natural History*, No. 73.

Elevation of the Coast of Chili.—That the latter coast is being gradually elevated, would appear from the fact that for half a century the harbours of the country have been diminishing in depth. This change, however, might be accounted for by supposing the existence of currents bringing in *débris*. M. Pissis gives other proofs. On examining the coast between Concepcion and Rio Maule, the various escarpments of schistose rocks will be found to present several cavities formed in other times by stone-boring mollusks; these markings succeed each other without interruption from high-water level to a height of from 8 to 10 metres (about 30 feet). The upper ones are much more crowded than those below, thus proving that the elevation has been gradual; for had it taken place at various intervals, there would be a series of interruptions in the series, which do not exist.—See *Comptes Rendus*, January 11th, 1864.

MEDICAL SCIENCE.

Nature of the Red Blood Corpuscle.—Dr. Lionel Beale, continuing his interesting inquiries into the distinction between the nature of *formed* and *germinal* matter, has communicated a paper on the above subject to the Microscopical Society of London. He arrives at two conclusions: first, that the blood corpuscle is not a cell, and possesses no trace of a cell wall; and, second, that the red substance is formed matter, and as such does not possess vitality, any more than cuticle, or the hard portion of horn or nail. That there is no distinct envelope is proved by the following facts:—1st. The corpuscles may be seen to alter their form under the microscope. This change is not due to pressure, because other globules having the normal form may be observed beneath those which are altering their shape. 2nd. If frogs or other large blood corpuscles are carefully subjected to sudden pressure under very thin glass,—as, for example, by drawing a needle point quickly and firmly across the thin glass,—several corpuscles will be divided into smaller ones. 3rd. Portions of the nucleus of a frog's blood corpuscle may be seen to pass completely through the coloured material, which of course would be impossible were this of a membranous character. This observation of Dr. Beale's is borne out by the statement of Dr. Roberts, who says, "I have on several occasions witnessed, after adding magenta, the total extrusion of the nucleus both in the frog and the newt, without the *least collapse of the corpuscles*." 4th. The corpuscles of guinea-pigs' blood shoot out into tetra-hedral crystals a few hours after being removed from the animal's body. Of this phenomenon, Professor Beale writes: "After a few minutes, these small particles were seen to change their form, and become angular, and gradually, very minute, but most distinct tetra-hedral crystals were

produced. Thus the coloured material of which a single blood globule was composed, gave rise to several distinct tetra-hedral crystals. The crystals did not seem to have been precipitated from any fluid contents of the corpuscle, nor was there any indication whatever of a cell-wall remaining." The whole of the red material became converted into crystals, thus satisfactorily proving the absence of an external envelope.—Vide *Quarterly Journal of Microscopical Science*, January.

Cause of Yellow Colour of Skin in Yellow Fever.—This has been attributed by Dr. S. Fleet Speir to the presence of Hæmatoidine. Having made a *post-mortem* examination of the body of a man who died of yellow fever, he found the following microscopic appearances. The contents of the stomach and intestines, which were acid, contained altered blood corpuscles, and abundant granules of hæmatoidine. The liver exhibited some large and fatty cells, but the majority of the latter elements seemed to have undergone the waxy degeneration: there was an abundance of hæmatoidine, and a few blood crystals were also to be seen. In the heart were found granules of hæmatoidine, the muscular substance having undergone fatty degeneration. The spleen, which was softened, contained abundant granules of hæmatoidine, so did the pancreas and supra-renal capsules, as also the skin and conjunctiva. The blood corpuscles were found altered and broken down.—Vide *American Medical Times*, November, 1863.

Action of Oil of Male Fern in Tape-worm Affections.—It having been deemed desirable by the British Medical Association, that a report on the therapeutic action of the oil of male fern should be made, the Society appointed a gentleman connected with Birmingham (Dr. Fleming) to compile the required information. This he has done. The report was published in the *British Medical Journal* (January 16th), and has, we believe, been reprinted in pamphlet form. The number of cases recorded is by no means as large as we should have expected, but is nevertheless sufficient to enable Dr. Fleming to draw a few conclusions, to one of which we would direct attention. It is stated, that the "measle" (we presume the cystic stage is the one alluded to) has "*a higher chance of escaping death in a weak stomach, and subsequently making a home for itself in the bowels.*" This is a fact of much interest, inasmuch as, *if correct*, it tends to show that in what the reporter would doubtless term "strong stomachs," *par excellence*, the so-called *cysticercus* ought to be destroyed!

Use of Alcohol in Phthisis.—M. Tripier read a paper at a late meeting of the French Academy, in which he expressed his opinion, that the employment of alcohol in cases of Phthisis was attended with beneficial results. He did not for a moment suppose that it was possible to cure the disease by the use of this remedy, but he believed that alcohol operated so as to check the paroxysmal cough and vomiting which are so frequent an occurrence in this dreadful malady. The *rationale* of the action is this:—there is produced a certain amount of local anasthesia, which prevents the reflex action necessary in order to produce secretion of the gastric juice. This follows from Bernard's experiments on dogs, in which digestion was always arrested by the introduction of alcohol into the stomach.—Vide *Révue de Thérapeutique*, February, 1864.

Last Blow to Teetotalism.—Triumph of triumphs to the common expe-

rience of all races of mankind, from the time of Noah downwards. It has at last been proved that all forms of alcohol are useful as articles of food. This was demonstrated beyond all question by the recent researches of M. Baudot, who draws the following conclusions from the results of his investigations :—(1.) Alcohol, when taken in moderate quantity, in the form of wine, brandy, rum, is not eliminated by the urine. (2.) In certain cases, scarcely appreciable traces of it may be found in this fluid. (3.) In some exceptional cases an appreciable quantity is detected, but it is always found in very small proportion to the amount swallowed. (4.) The Alkalimetry system may be employed to detect the alcohol, when this latter is present in small quantities. (5.) The solution of bi-chromate of potash in sulphuric acid is a much more sensitive test than is required in these operations. (6.) It may then be concluded that alcohol is destroyed in the economy, and that it fulfils the part of an element, as has been said by Liebig.—*L' Union Médicale*, 135, 140, 141, and 142.

The new Pharmacopœia.—This long-expected work has at last appeared, and like most things of which a great deal has been anticipated, has given rise to much disappointment and dissatisfaction. It would be impossible in our limited space to undertake an analysis of this work, but we can conscientiously affirm that there never has been a work upon which so much money was expended with so inadequate a result. The compilation and arrangement of the new Pharmacopœia cost several *thousand* pounds, and might have been turned out better if placed in the hands of a single individual, and at a cost of a few hundreds. The omissions it exhibits are numerous. We think that in regard to this production, the expression employed by Lord Derby to designate the foreign policy of the present Government, may be fairly applied to the Medical Council. Their proceedings may be truly styled "*meddle and muddle!*"

Is Carbonic Acid formed exclusively in the Tissues?—This question is answered in the negative by Herr J. Sachs, who, from the results of his investigations, avers that carbonic acid is being constantly generated in the blood at the expense of the oxygen which it contains. He draws the following general conclusions :—1. The gases contained in the blood after its removal from the body, at ordinary temperature, undergo marked changes in their relative proportions : the oxygen gradually disappearing, and the carbonic acid taking its place ; the quantity of the latter being always greater than that of the oxygen which has disappeared. 2. The quantity of carbonic acid that is chemically combined increases with the interval at which it is examined after removal from the body. There is always a greater quantity of chemically combined carbonic acid in venous than in arterial blood. 3. It seems probable that after forty-eight hours, the quantity of oxygen remaining in the blood is reduced to a mere trace. 4. It is difficult to draw accurate conclusions regarding the proportion of nitrogen. 5. It is absolutely necessary that fibrine be present, in order that carbonic acid may be formed ; but it is impossible to say in what manner the fibrine acts in assisting the formation of the gas. — Vide *Medico-Chirurgical Review*, No. 65 ; and *Reichert's & Dubois-Reymond's Archives.*

Dilatation of Pupil simultaneous with general Muscular Exertion.—It would appear from the researches of M. R. Vigouroux that, whenever any energetic muscular movement, either of the body, or of inspiration or expiration, takes places, the pupil is dilated; the dilatation varying from one-third to one-fifth of its previous diameter. This peculiar fact he thus explains:—Whenever a nervous centrifugal current traverses the spinal chord at the level of the origin of the first two pairs of dorsal nerves, a portion of the current is derived [diverted?] towards the pupillary filaments, which separate from their nervous centre, and effect the contraction of the radiate fibres of the iris.—*Ibid.*, and *Gazette Médicale*, 1863, p. 664.

The Mechanical Power of Muscles.—A valuable paper on this subject was recently contributed to the *Edinburgh New Philosophical Journal* (vol. xviii.) by Mr. H. F. Baxter. His experiments were carried out in the gastrocnemius muscle of a living frog, and his generalizations are thus expressed:—(1) One grain of muscle is capable of lifting a weight of 608 grains through a space of $\frac{1}{5\cdot3}$ of an inch. (2) Sex has an important influence over the results; males being, as a rule, more powerful than females. (3) The weight of the animal before the experiment gave no reliable indication as to the real muscular power. (4) During experiment there was a loss of weight of the animal, but an increase of weight in the muscle experimented on. (5) An increased nutrition of the muscle was indicated by its weight, its vascularity, increase in the activity of its electrical condition, and by the maintenance of its muscular power. (6) Circumstances influencing the health of the animal, such as absence of food, temperature, and confinement, have an important influence over the results. (7) The maintenance of the circulation of the blood is of the utmost importance in these experiments.—*Medico-Chirurgical Review*, January, 1864.

A New Remedy for Asthma has been described by Dr. McVeagh, in a late number of the *Dublin Quarterly Journal of Medical Science*. Whilst visiting an Irish nobleman who was attacked with asthma, he learned from him that the seeds and plant of *Datura tatula* when smoked, invariably gave him relief, and that he first employed this remedy when at Malta. In the garden of the Governor of Malta large quantities of this thorn-apple are to be found, and the plant is used by the inhabitants as a cure for asthma. It has some advantages over *D. stramonium*, being more powerful as an antispasmodic and less so as a narcotic. It may be smoked like tobacco, or may be employed as tincture or extract; the dose of the latter is from half a grain to a grain and a half, and of the former from 20 to 60 minims.

Are Vaccine Virus and Variolus Virus distinct?—We find that this question has recently been ably discussed in the French Academy of Medicine. M. Dupaul contended for the accuracy of the several conclusions, of which the following are a few:—(1) The vaccine, as a thing *per se*, has no existence; it is nothing more nor less than the variolus virus. (2) That cows and sheep are, like man, subject to small-pox. (3) The general and local phenomena seen in such cases in these animals are similar to those observed in man. (4) We may inoculate man from the

horse, and conversely. (5) In both animals variola may appear, sporadically and epidemically. (6) When small-pox occurs among men, it often extends itself to other animals, or conversely, it may first appear among the latter and be communicated to the former. (7) The dangers of inoculation of variola in man have been greatly exaggerated, as any one who impartially considers the evidence on the subject will admit.—Vide *Gazette Médicale*, November and December, 1863.

Cause of the Production of Scapho-cephalic Skulls.—Dr. Turner, of the University of Edinburgh, has written an exhaustive essay on cranial deformities, in which the above is well explained. It is a remarkable fact that in all scapho-cephalic skulls the sagittal suture becomes obliterated in early life; an entire conversion of the bone-forming blastema into bone occurs, and hence the cranium cannot be enlarged to any great extent in the transverse direction. Now, as the brain increases in size, it becomes necessary that the skull's capacity shall also increase *pari passu;* this increase cannot take place laterally, and hence the bone-developing plasma lying in the occipital and coronal sutures is obliged to undertake the labour of enlarging the brain-case, which thus becomes prolonged in the antero-posterior direction.—Vide *Natural History Review*, January.

The Use of Nitrous Oxide in Dental Operations.—Under this title will be found a most interesting contribution to the *Dental Review* (Hardwicke), from the pen of Mr. Samuel Lee Rymer. The history of the employment of protoxide of nitrogen as an anasthetic is easily given, but the writer does not at once concur in the opinions of his American brethren as to the efficacy of laughing-gas in dental cases. With a cautious reserve which does him much credit, he observes, "I have not much doubt that transient anasthesia may, in almost all cases, be produced safely by the *proper* inhalation of the gas; by which I mean not only the exhibition of pure nitrous oxide quickly, but the exercise of some discrimination in allowing its exhibition at all. . . . . To arrive at a definite conclusion upon the safety of the nitrous oxide, perhaps the best mode of procedure would be to subject a number of animals to its influence, before experimenting largely upon the human subject."—Vide *The Dental Review*, January, 1864.

METALLURGY AND MINING.

Direct Production of Wrought Iron and Steel in the Blast Furnace.—A very interesting method for obtaining the above result has recently been patented by Mr. Johnson, of Lincoln's Inn Fields. The process consists essentially in the introduction of finely divided oxide of iron into the blast, which, of course, conveys it to the metal in the furnace. The result of this introduction of oxide is that the cast iron becomes decarbonated in the blast-furnace itself, without being placed in puddling or other furnaces. Any other oxide which acts in a similar manner may be employed with equal advantage, and other substances may also be employed for the purpose of purifying the metal. The crucibles which are usually employed must undergo some modification in order to admit of the patented system being carried into execution. It is thought advisable

to heat the oxide to dull redness before allowing it to enter the blast pipe. —Vide *Mining and Smelting Magazine*, February.

Coating Iron with Aluminium.—Mr. Wm. Clark has invented a peculiar process for covering the surface of iron with a layer of the latter metal. The surface of the iron is first cleansed ; a mixture is then made of porcelain-clay, feldspar, and white lead, properly ground and incorporated ; then about ten parts of this combination are added to about five pounds of calcined and powdered alum-clay. This last mixture having been made into a thin paste, and poured over the surface of the metal, the latter is dried and placed in a reverberatory furnace until it presents a glazed appearance. When the iron is removed it will be found to have received a tough, adhesive, and elastic coating, which is so closely attached to the metal that, when this is bent even at right angles, no symptoms of cracking appear. This coating is also unacted on by acids and alkalis. It is supposed that during the baking-process the aluminium is separated from its oxide and forms a thin metallic stratum, intermediate between the iron and the glazed surface.—*Ibid.*

New Method for the Extraction of Silver.—This has been adopted by Ziervogel, in order to remove the silver from copper regulus. There are three stages in the process :—1st, the roasting of the ground ore. This is effected in a reverberatory furnace, and in itself is a double process ; viz., the conversion of the sulphides into the sulphates, and the decomposition of them, so that, while the sulphate of silver remains unaltered, the other sulphates are deoxidized ; 2nd, the lixiviation and precipitation of the silver by means of copper ; and, 3rd, the drying and refining of the silver itself. It is stated that this method has superseded that of Augustin, which was formerly employed at the Mansfeld Copper Works.

An Improved Form of Davy-lamp has lately been patented by Mr. P. Bourne. Its peculiarity consists in a means of extinguishing the flame in the act of opening the lamp, and before the wire gauze can be removed. There is attached to the lamp, near the neck-holder, an apparatus, composed of one or more levers mounted on a suitable fulcrum, and which apparatus is capable of being depressed on the wick by the act of removing the wire-gauze covering. The apparatus is, by the application of a suitable spring or springs, kept out of the way of the ignited wick, so long as the gauze covering remains on, or when it is being placed on the lamp ; but as soon as an attempt is made to elevate the covering, the series of levers comes into play, and the wick being pressed on, the flame is consequently extinguished.—Vide *The Artizan*, February.

Our Iron Exports to France have fallen off sadly of late, whilst the exportation of pig iron has remained nearly as it was in 1862. The value in money of the iron exported to France in the first ten months of 1863 was only £174,238 ; the value of that exported during the corresponding period in 1862 being £824,774. It is difficult to account for the diminution, but some attribute it to the fact that the prices in France have not risen proportionately to the rise established in England and Belgium.

Novel Electric Fuse for Blasting Purposes.—This, which is a French invention, differs from all those previously employed, and appears to be highly spoken of. It admits of being rapidly manufactured, whilst the

chances of fracture are reduced to the smallest number. It consists of an insulated wire, to which the usual fuse-tube is attached, and has a second wire, uninsulated, coiled round it, so that its extremity is about a centimetre from that of the first. Finally, there is a bag attached to its extremity, containing the explosive compound. When an induced current is passed through the wires, the spark traverses the powder contained in the pouch: it melts the tin thread employed to complete the circuit, and passes through both wires. By adopting this process a great number of blasts can be exploded simultaneously, as there may be branch wires from the main stem to various other localities.

Action of Manganese in the Smelting of Iron.—In concluding a memoir, presented to the Royal Academy, on this subject, M. H. Caron observes that, in mixing with their ordinary ores those which contain large quantities of manganese, with a view to the improvement of the products, iron-masters may with advantage gradually increase the proportion of flux, without rendering their slag less liquid to any injurious extent. He recommends the employment of sea-salt, or chloride of calcium, when the flux becomes difficult to manage. He also suggests the use of fluor spar or cryolite, but states his objection to these substances, on the ground of their containing considerable quantities of phosphoric acid, which is exceedingly destructive of cast-iron.

Manufacture of Copper.—A patent for the separation of copper from regulus has been granted to Mr. Fleitmann, a Prussian. His process is as follows:—Having obtained an ore which contains, as impurities, only arsenic, antimony, and phosphorus, he grinds it to powder, and roasts it; and the crude oxide which he obtains in this way is moistened with a solution of caustic alkali, dried and again heated, avoiding a temperature sufficiently high to fuse the oxide of copper, but at the same time employing one adequate to fuse the alkali. By this process metallic impurities are got rid of; and when the mass is mixed with water and washed, the pure metal may be obtained from the oxide, either by carbon, or by carbon and hydrogen conjointly.—See *Chemical News*, January 23.

Oil-lamp Furnace for Melting Metals at a White Heat.—It may seem almost surprising that a sufficient temperature can be produced from the combustion of oil to fuse metals, yet such is really the case. In the *Chemical News* for January 2nd a description will be found of a furnace of this kind, which has been contrived by Mr. Charles Griffin. It is most ingeniously constructed, sold at a moderate price, and must prove invaluable to those engaged in the pursuit of metallurgical studies, in localities where coal-gas cannot be had. The oil used is of the mineral or rock kind, and the combustion of a quart of this (which costs only ninepence) gives a heat sufficient to fuse five pounds of cast iron. The furnace being cold when an operation is commenced, it will melt a pound of cast-iron in twenty-five minutes, 1½ lb. in thirty minutes, 4 lb. in forty-five minutes, and 5 lb. in the course of a single hour. This furnace possesses one peculiar advantage over the coal-gas forms; viz., platinum crucibles remain uninjured, as the rock oil in combustion gives off no sulphureous vapours.

METEOROLOGY.

Isothermals of the British Isles for July and January.—This is a subject upon which all feel interested. It has been well treated by Mr. A. Buchan, in the *Journal of the Scottish Meteorological Society* for January, 1864. His paper is accompanied by a map, upon which are seen two series of lines, one in blue, the other in red, which represent respectively the equal heats of various localities in January and July. The data upon which the conclusions drawn have been founded are taken from the reports of the various Meteorological Societies existing throughout the country. The numbers given stand for the temperatures at the sea level; and hence, in order to calculate the exact heat, it will be necessary to subtract one degree of Fahrenheit for every 300 feet elevation. With regard to the lines of equal summer heat, there are some points which deserve special attention. The general slope of the lines is from north-east to south-west, which indicates that the eastern portion of the British Isles enjoys a higher summer temperature than that which lies to the west. This is due to the fact, that the prevalent wind in July is westerly, and, coming over the Atlantic, renders the west coast cooler than the east; and also to the circumstance, that the clouds in the west are greater in volume and lower than those in the east. The curving northward of the lines in the central portion is due to the width of the land, which allows the middle portions to have more of a continental temperature than the borders. The high winter temperature of the west coast is due to three causes:—(1) The warm south-west wind, which loses some of its heat before reaching the east coast. (2) The larger amount of vapour deposited in rain on the west coast (nearly double that in the east), which thus liberates a very large quantity of latent heat. (3) The larger amount of vapour in the west, which obstructs radiation, not only when in a visible state in the form of clouds, but also when dissolved through the atmosphere in an invisible state, in which condition, as shown by Professor Tyndall, it prevents the radiation from the earth of the heat which has been absorbed from the sun.

Non-Cyclonic Character of the Storm of October 29, 1863.—The Rev. Samuel Haughton addressed a letter to the Royal Irish Academy, at its sitting in November 30, in which he shows that this storm was not a true cyclone. He says, the wind in Dublin blew steadily from the south-west during, and long after, the gale; while in Armagh it seems to have shifted through 132 degrees from 10 a.m. to 1 p.m. The gale in Dublin was at its height at 11 a.m., when the wind travelled at the rate of sixteen miles per hour. Perpendiculars drawn to the directions of the wind at this hour, from Dublin, Armagh, and Ballinasloe, nearly intersect in Lough Melvin, in the county of Fermanagh (a circumstance which at first sight would seem to prove that the storm was a cyclone). But if a line be drawn parallel to the bisector of the angle produced by the direction of the wind at Armagh, at the hours of 10 a.m. and 1 p.m., it is well known that the gale should have travelled along this line. If this had been the case, the

centre of the storm should have passed near Ballinasloe, when the wind should have changed through 180 degrees. But as this occurrence did not take place, this storm could not have been a cyclone.—Vide *Dublin Quarterly Journal of Science*, January, 1864.

How the Storm of the 2nd and 3rd of December originated.—M. Vaillant has presented a memoir to the French Academy on this subject. He conceives that storms such as the above are produced by the collision which takes place between two currents of air, one of which is warm, the other cold, the latter being produced by heavy falls of snow in certain localities. He ascribes the storm of the 2nd of December to the meeting of the moist and warm wind, which at that time overspread Europe, with the cold wind which blew in every direction; but in France from the north-west, and which was produced by the cold effected by a heavy fall of snow in Scotland. What supports this view is the fact, that the storm of the 3rd was like that of the 2nd. The wind was due south at eight in the morning, then it became south-west, then west, and finally north-west, when the storm abated, because the collision between the two winds had occurred.—*Comptes Rendus*, lvii. No. 25.

The Aërial Currents of the Globe.—Under the title of terrestrial physics, we notice an interesting *resumé* of what is already known upon the subject of atmospheric currents. This has been sketched out by M. Martin Saint-Leon, and is as follows:—The general circulation of the atmosphere is produced by the difference in temperature of different localities, and hence is modified by the seasons. At the equator, between the warmest and coldest periods of the year, the variation is slight, and, with a few exceptions of local origin, this variation increases with latitude. From this it follows that towards the end of the northern climatologic summer, the north-east inferior current is slackened, and towards the end of the winter is accelerated. This is doubtless the reason that, between the tropic of Cancer and the Equator, the autumn is invariably the hottest season, and the spring the coldest. The periodic colds of April in our climates may be attributed to the activity of the inferior north-east current. At Paris, the absorption of heat by the earth commences about the 15th of January, but as we approach the poles this process is later. About the end of winter the inferior north-east current has increased in power, and constitutes a wave which passes over France towards the middle of April. The influences of lands and other local causes modify the direction of the inferior currents; wind currents also in the neighbourhood of continental surfaces are often opposite in direction to the general movement. The subject of surface currents is one for the consideration of the navigator. The general inferior current is nearly 8,000 metres high, and its movements may be detected by watching the small white clouds called cirrhi, which travel with it. It is easy to conceive of the numerous advantages arising from this constant circulation of the atmosphere. The heated air is elevated; it abandons its moisture on cooling, and gives it in the form of rain to the parched-up soil. At the same time the heat is distributed over other latitudes, instead of being allowed to accumulate at the Equator.—Vide *Presse Scientifique des deux Mondes*, vol. 2, No. 22.

MINERALOGY.

Presence of Chabasite in Granite.—The existence of this mineral in granite rocks has been pointed out, in a communication from Herr Ulrich, to the Natural and Physical Society of Bonn. The chabasite was discovered in certain cavities of the rocks in which the author had formerly discovered calc spar. The discovery is of considerable interest, inasmuch as this mineral was never before found in granite. Simultaneously with the above discovery, we have to record the discovery of this mineral by Rose in the granitic deposits of Connecticut.

Vanadium in Pig Iron.—In the samples of pig iron from various parts of Wiltshire, this mineral has been detected by Mr. Edward Riley. In making his analyses of certain specimens, the residue from the silica was regarded as titanic acid ; but it was very soon found that this supposition was erroneous, for the so-called titanic acid was in reality Vanadium. The most effective process for its extraction is the following :—The borings are placed in dilute hydrochloric acid, and after the pig is nearly all dissolved, strong acid is added, and the solution is boiled. The chloride of iron is then filtered off from the graphite and silica, and the filter is well washed from chloride of iron, and treated with a dilute solution of potash to dissolve the silica ; the potash is then thoroughly washed out, the filter is treated with hydrochloric acid, washed to remove acid, dried, and ignited. The residue left is a semi-fused mass, apparently consisting of a mixture of a fusible and infusible oxide, which stains a porcelain crucible yellow, and adheres strongly to it ; some portions of the mass being of a purply blue colour, similar to the bloom on a plum. That this residue is vanadium, is proved by the reaction of its solution with various compounds, and more especially with ferro-cyanide of potassium.—See *Journal of the Chemical Society*, January, 1864.

Characters of Carphosiderite.—The characters of this rare mineral have been given by M. Pisani, in a memoir presented to the French Academy. Carphosiderite (which was first foun din Greenland, by Herr Breithaupt) consists of a sub-sulphate of hydrated peroxide of iron. Mineralogist readers, no doubt, remember that when this substance was analysed by Harkort, it was stated to have been a phosphate. In its natural condition carphosiderite presents itself in uniform masses of a straw yellow hue, it has a

hardness = 4
density = 2·728

When heated it gives off sulphurous acid, and becomes red. It is insoluble in water, but soluble (leaving a residue) in hydrochloric acid ; the solution is yellow, and contains iron in large proportion. This mineral contains a mixture of gypsum perceptible to the naked eye, and which may be washed out with water. The following is the result of an analysis :—

Sulphuric acid	25·52
Peroxide of iron	40·00
Oxide of manganese	a trace
Gypsum and other substances ...	23·81
Water	14·67

From the above table it will be inferred that this mineral is no longer to be regarded as being (what even the last edition of Dana's Mineralogy states) a phosphate. It has a formula analogous to that of Apatelite.—*Comptes Rendus*, February 1st.

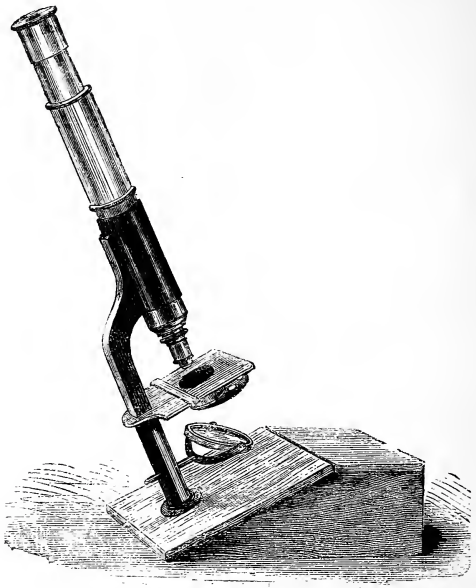
Densities of the various Forms of Zircon.—M. A. Damour read a valuable paper on this subject, before a late meeting of the Academy. From a series of analyses he is led to infer that the differences in densities are not due to differences in chemical composition, but are rather the results of special *molecular* conditions. The variation in density extends from 4·04 to 4·67, and is well illustrated in the interesting tables which accompany his paper. He concluded by stating that the question was one of geologic interest, for it is remarkable that the Zircons of syenitic and basaltic rocks have always a high density. This mineral has been artificially formed by acting on Zirconia with fluo-silicic acid.—See *Comptes Rendus*, January 18th, 1864.

MICROSCOPY.

A New Stand for a simple Microscope has been devised by Mr. Richard Beck. The stage supports a revolving disk on which the object is placed, and the arrangement is such that, while the magnifier remains in one position, the object can be turned so that it may be viewed in every aspect, losing nothing in point of illumination, although its position is altered. It is accompanied by a concave mirror and a condenser, and moreover is so contrived that the case which contains it leaves room for the enclosure of a good sized box, for dissecting instruments and apparatus. By means of a very simple prismatic arrangement this instrument may be made binocular. —See a Paper read before the Microscopical Society, and printed in the *Microscopical Journal* for January, 1863.

New Microscope for the Use of Families.—An instrument which is intended for family use has been constructed by Mr. Samuel Highley, of Green-street, Leicester-square. It is certainly of its kind, and considering the price at which it is sold, the best of all the cheap microscopes which we have seen. The annexed cut gives a better idea of the general form of the instrument than any words of ours could convey. It is so contrived, that when ready for use it is inclined at a fixed but convenient angle, and by reason of its attachment to the case which carries it, combines simplicity of structure (no mean advantage to the amateur) and portability. It is not provided with a rack movement, but, like Messrs. Smith & Beck's "Educational," the body slides with extreme ease and uniform telescopic motion, which allows the object to be readily brought into view; the accurate focus is then obtained by Dr. Beale's method of draw-tube fine

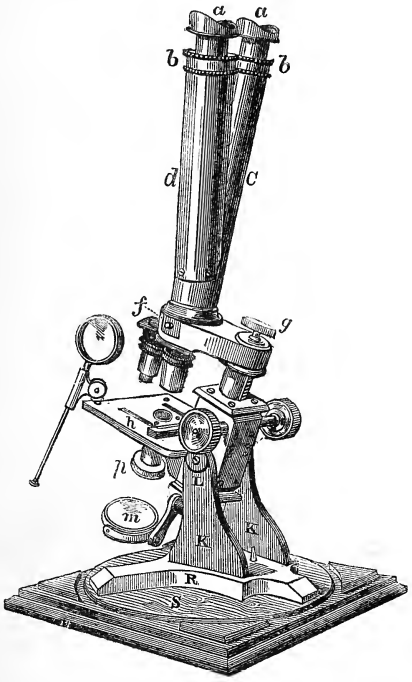
adjustment. It is supplied with a medium eye-piece, and an inch and half inch objectives; and carries a concave mirror, and wheel of diaphragms.



MR. HIGHLEY'S NEW FAMILY MICROSCOPE.

New Binocular Microscope.—There are very few instruments of the binocular type which can be said to surpass in cheapness, workmanship, or clear powers of definition, the instrument which Mr. Collins exhibited at the late conversazione in University College. This microscope, which, by the way, is constructed upon a plan of Professor Harley's, seems to appeal above all to the working naturalist and anatomist; for it is so contrived, that a great saving of time is effected in the alteration of apparatus. We would call especial attention to the arrangement of parts at the lower end of the body of the microscope. Here we find a sort of oblong box moving to the right and left of the observer; in this are placed a Wenham's binocular prism and the analysing portion of the polariscope; so that by simply moving this box in the lateral direction, we convert the microscope from a binocular into a uniocular, and, if we desire it, can bring the polariscope into action also. Those who are familiar with the working of our ordinary microscopes, will at once appreciate the advantage of Mr. Collins's arrangement. The eye-pieces are provided with shades, which afford considerable relief to the eyes during prolonged investigations. This microscope is supplied with the usual accessory apparatus, and also with two excellent objectives, 1-inch or 2-inch, and $\frac{1}{4}$-inch, and when packed in its *newly* contrived mahogany case, is sold by the maker at the moderate price of £12. There is but one thing in connection with this microscope which does not appear to us to be of advantage, and that is, the magnetic

stage; this, however, is a trifling objection when compared with the many good qualities of the instrument, which certainly commends itself to those who desire "a binocular."



MR. COLLINS'S NEW BINOCULAR MICROSCOPE.

In regard to the progress of the so-called "Microscopic Science," we beg to refer our readers to the pages devoted to those branches of science in the study of which the microscope is employed. If a science is to be designated by a term compounded in part of the name of the instruments employed in its pursuit, then we shall have to coin new expressions of Greek and Latin derivation, to show that geology is the science of hammers, zoology of dredges, &c. Beneath are appended the titles of the notices which some of our readers may be in search of:—

Botanical Section—
What is Palmogloea Macrococca?
Distribution of Raphides.
Spontaneous Generation.
Geological Section—
Foramenifera of the Tertiary Basin of Vienna.
Medical Section—
Nature of the Red Blood Corpuscles.
Yellow Colour of the Skin in Yellow Fever.
Zoological Section—
Variation of Species among Rhiz ρods.
Structure of the Animal Substa of Difflugia.

PHOTOGRAPHY.

Photographic Engraving.—A cheap and efficient method of engraving, direct from an artist's drawing or photograph, was one of the earliest suggestions arising out of the introduction of photography, although it is one of the latest to be fairly carried out. Some of the art's most able and daring experimentalists have devoted their attention to the idea, and almost every mode by which a surface for printing can be obtained, has been duly tested for this purpose. Thus, we have had photo-galvanography, photoglyphy, photo-lithography, photo-zincography, and photo-block-printing. Each of these has been found more or less unsatisfactory, one requiring too much assistance from the graver, another failing in the registration of the more subtle gradations of tone, &c. Early, however, in the present year there was presented to the readers of one of our contemporaries—the *Photographic News*—a specimen of an engraving process, called the "photo-electric," introduced by Mr. Duncan C. Dallas, which was certainly far in advance of anything of the kind we have yet seen. This specimen, unassisted by the engraver's hand, was a reproduced photograph, having not only all the beauties of the original, but also all its faults. It had the same want of relief in the relative parts of foreground objects, and the same imperfect expression of light and space, while the tasteless substitution of white paper for a softly retiring sky destroyed everything like tone and brilliancy in the other portions of the picture. But even this process has its failing, and this will be found in the heavy opacity of the deepest shadows, which is due, we are informed, to a defect in the ink-holding capacity of the surface in such parts of the plate. The number of impressions which a plate engraved by this process will produce—if the method of steel-facing be adopted—is unlimited; and its inventor informs us, that its cost is about half that of a plate engraved in the ordinary way. The process is at present a secret one.

Carbon Printing.—A very generally admitted need of permanency in photographs long since originated a desire for producing them in some such reliable material as the ordinary printing ink-carbon. At a meeting of the North London Photographic Association, which took place early in January, Mr. G. W. Simpson called attention to some very marked improvements made by Mr. Pouncy in his carbon-printing process. The early experiments of this gentleman, although frequently pressed upon the attention of the photographic world, as productive of perfect results, were really very unsatisfactory, but the specimens introduced on this occasion were remarkably promising and attractive. The process by which these were produced is thus described. A thin oiled paper is coated with a mixture of printer's ink and asphaltum, thinned with a saturated solution of bichromate of potash dissolved in turpentine. After being exposed to light under a negative, with the side not prepared in contact with the glass, it is submitted to the action of turpentine, which dissolving out more or less such portions of the prepared coating as have been partially or entirely secluded from the light, thus forms the image. This

photograph is then transferred from the oiled paper to card-board, by simply pasting the former face downward on the latter, and when dry using moisture for removing the oiled paper. By the same process, closely resembling that of the earliest French photographic experimentalist—it will be easily seen that the image may be transferred to stone for lithographic purposes.

The objections to this method are, the exactness required in regulating the exposure to light, and the imperfect transparency of the oiled paper through which the image is printed. The prints we have seen by the process, although very soft, were poor and tame, wanting in clearness of definition and vigour of effect.

Since then, a process of printing in carbon, giving the very finest results, and divested, we are informed, of all such objections, has been announced at a meeting of the South London Photographic Society, and by the same gentleman, Mr. G. W. Simpson. The specimens exhibited on this occasion were quite equal to the best silver prints we have seen, and were produced by Mr. Swan, of Newcastle-on-Tyne, an amateur photographer of no mean skill. It is uncertain at present whether this valuable process will be preserved as a secret for the benefit of the inventor, or given up to the whole photographic world for the benefit of the art and the advantage of the public. We have been informed that Mr. Swan leans to the more generous idea; if so, he is indeed an amateur in the loftiest sense of the word.

The reported Watt Photographs.—Fresh light has been thrown upon the alleged early photographs, and their claims appear thereby more doubtful than ever. Mr. Sutton has pointed out that, if the paper pictures were produced by the aid of a lens, internal evidence would show that such a lens must have been a more perfect optical instrument than any modern photographers can obtain. Some of the evidence first advanced has been completely set aside, and evidence in support of fresh claims takes its place. At the January meeting of the London Photographic Society, the subject was again discussed at some length. With regard to the photograph of a breakfast-table, described as the work of Thomas Wedgwood, in 1792, Dr. Diamond and Mr. Malone brought forward photographs of the same subject taken twenty years since by Fox Talbot. A letter from Mr. Robert Hunt gave reasons for denying that the paper pictures were produced by light, although he believed there was no doubt that those on metal were photographs, taken probably by a resin process, similar to that used by Wiepce, in 1814. Doubts were also thrown upon the veracity of Mr. Price, in a letter, and part of a pamphlet, by a grandson of Matthew Boulton, who, while admitting that light was the agent most probably used in the production of the Soho reproductions, adds, "accuracy was not Mr. Price's forte." A manufacturer of copper plates thought those on which the pictures in question were taken could not be more than twenty-four years old. On the other hand, a letter from Mr. Fairholt, who had been consulted as an expert in matters of this kind, expressed a conviction that the pictures were really photographs. Mr. Boulton, in the pamphlet above mentioned, also affirms that the library which was said to have been cleared out twenty years since, was really

cleared out at a date not earlier than 1847; and that, instead of Miss Wilkinson disposing of the old camera in ignorance of its use, she had herself frequently used it. A lady, it is also stated, remembered Miss Wilkinson taking what she called "sun-pictures" somewhere about twenty-eight years ago. And other evidence has been obtained by Mr. Smith, which it is said will prove that this lady produced photographs at a still earlier period. Moreover, the said long "hermetically" closed library appears to have been always in daily use. At the same meeting, another early photograph appeared, said to have been taken in Edinburgh in 1834. After the publication of these facts, several suggestions and statements were advanced in the pages of our various contemporaries. A correspondent of the Journal of the *Society of Arts*, in whom we recognize a gentleman well acquainted with the subjects of etching and engraving, affirmed that the pictures were really aqua-tint engravings, and pointed out as evidence the mark of the plate in the proofs examined, &c., accounting for the impressions being removable with rubbing, by supposing they were obtained on a surface of gelatine, and that this gelatine having perished the impressions were no longer adhesive. Dr. Henry Lee, in a letter published in the *Illustrated London News* said:—"In confirmation of the statement made by the old man formerly in the employ of Matthew Boulton, Esq., I very well remember having heard from my mother many of the particulars, which leave me no doubt of the truth of his statement." The matter will again be brought before the Photographic Society, when it is hoped some more important evidence than mere hearsay or assertion will set this matter fairly at rest.

Exhibition of the London Photographic Society.—It has been definitely settled that the next exhibition of the London Photographic Society will be held in that very small room in which the pictures of the "*Society of Female Artists*" now are, and that it is to remain open during the months of May, June, and July. In consequence of the small space which will be at the disposal of the Hanging Committee, touched and painted photographs are to be excluded. We question the policy of this arrangement. In the first place, photographic exhibitions are largely supported by photographers whose leisure hours are certainly not found during the bright weather and the London season; and in the next, the most popularly attractive feature of photographic exhibitions is the painted portraits of public characters and noble personages. The conversation of the visitors at such exhibitions has demonstrated this to us very clearly upon several occasions, when friends, relatives, and admirers sought little beyond the latter productions, while the critical remarks upon the untouched photographs were as evidently those of the art's amateur or professional practitioners. For the months selected outdoor attractions have certainly the better chance of success.

New Process of Photographic Printing.—In *Le Moniteur de la Photographie*, M. Liesegang has recently called attention to a process of printing, by which that costly material, nitrate of silver, may be abandoned in favour of less expensive metals. M. Obernetter, of Munich, is the inventor of this process, which is thus described. The plain positive paper is floated for two minutes on a bath prepared as follows:—

Water	35½ ounces
Solution of sesquichloride of iron, sp. g. 1·53 to 1·6	200 grains
Chloride of copper, crystallized	1,543 „
Pure hydrocloride acid, concentrated	185 „

The paper is now sensitive, and after being exposed under the negative requires development by immersion in the following solution:—

Water	35½ ounces
Sulphocyanide of potassium	120 to 130 grains
Concentrated sulphuric acid	15 grains
The solution employed for preparing the paper	150 to 300 grains

After floating the print on this bath for three or four minutes, it is immersed therein and remains for from five to thirty minutes, according to the mode of toning intended to be adopted. Fresh solution may replace that absorbed by the paper, and the bath will be found to improve by use. When developed, the proof is thoroughly washed in pure water from fifteen minutes to one hour, the latter being always sufficient, and then may either be toned at once or dried and toned at any future time. Proofs thus obtained may be brought to almost any required colour, either by immersion in a solution of from 6 to 12 per cent. of red prussiate of potassa, or in the following:—

Water	200 to 300 cubic centimetres
Protosulphate of iron	100 grammes
Perchloride of iron	40 „
Hydrochloric acid	80 „

In using this bath, the water in which the print is afterwards washed must be acidulated. Photographers who use large sheets of paper for printing life-size portraits and large landscape pictures will doubtless rejoice in the publication of a process so economical.

Adulteration of Chloride of Gold.—A discussion has arisen in the photographic journals on the subject of the adulterations so commonly made in chloride of gold, which, started by Mr. J. T. Taylor, sub-editor of the *British Journal of Photography*, has been continued by the editor of the *Photographic News* and promptly taken up by some correspondents in both these serials. The evidence advanced seems to show that before the photographer can get his fifteen grains of gold half its value is generally demanded for profit, and that in each such quantity there is frequently not more than six and three-quarter grains of pure gold. The subject has been before referred to, and Mr. R. Reynolds even went so far as to call the attention of the British Pharmaceutical Conference to the common nature of this fraud. As it is very desirous that operators should know the exact strength of the solution they have in use, several tests have been suggested, one of the most reliable of which, if not wholly reliable, is suggested in the facts that the most common element of adulteration is the chloride of sodium, cadmium, or strontian, either of which is not soluble in alcohol, while chloride of gold is. Mr. Taylor however denies that alcohol forms a sufficiently reliable test, and as the test by analysis is a very delicate operation, which has the further disadvantage of rendering the gold useless for

photographic purposes until reconverted, and the making of chloride of gold is a very simple operation, this gentleman wisely recommends the latter process to his brother photographers as the best means of self-defence with which he is acquainted.

Action of Hot Water on Photographs.—A correspondent of the *Photographic News*, complaining of the ill effects produced upon certain of his photographs by the use of hot water, as a means of more readily and efficiently freeing the prints from the decomposing agent, some interesting correspondence is the result, which tends to prove that it is only when a photograph is improperly fixed that the heat of the water exercises any deteriorating influence upon it.

Strong v. *Weak Printing Baths* has been one of the subjects with which the photographic societies have been busy during the past three months, but the evidence advanced is so conflicting, and the arguments made use of so contradictory, that few reliable conclusions seem to have arisen therefrom.

A New View Camera, the novelty of which is that it has a moveable front contrived to do away with the necessity for a "swing-back," was introduced to the members of the *Photographic Society of Scotland*, by Thomas Sutton, B.A., editor of *Photographic Notes*. This method may be, perhaps, more convenient than that of a "swing-back," but we do not perceive that it possesses any other special advantage, and rather suspect that in practice it may be found to have certain disadvantages which the older form of camera escapes. A similar opinion was expressed, we believe, by Sir David Brewster, at the meeting before which it was exhibited.

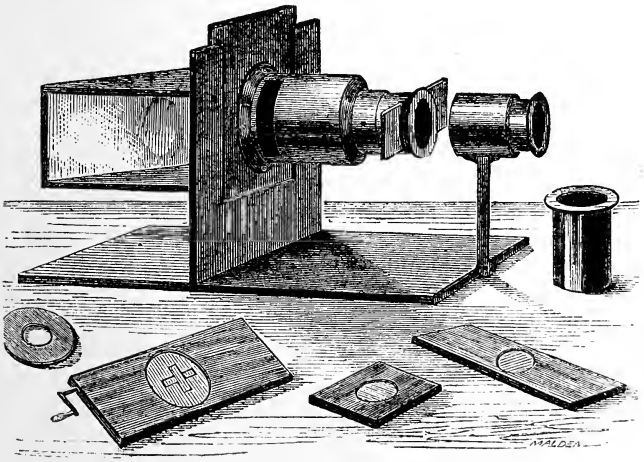
New Method of Restoring Faded Photographs.—At the January meeting of the North London Photographic Association, Mr. H. J. Godbold described a method of restoring faded photographs, which consists in immersing the faded specimen in a solution of bichloride of mercury (1 grain to the ounce of water) and letting it remain therein until the colour has grown warmer, and the yellowness has disappeared.

New Portrait Lens.—Mr. Sutton's craving for improvement and novelty in the photographic appliances is continually originating some fresh suggestions, some of which die in their very birth-throes, while others are mere scientific curiosities, and others again are turned to very useful and profitable account. The more recent of this gentleman's introductions is a new view lens, in the form of a very hollow meniscus, with the stop placed much nearer than usual to the lens. This is said to give images having much less spherical aberration than the common plano-convex view lens. Another new portrait lens for moving objects requiring to be taken with extraordinary rapidity under unfavourable circumstances of light, or in a glass-room, has also been introduced by Mr. Henry Squires. It being desirable that our new infant Prince should be photographed, His Royal Highness the Prince of Wales was naturally curious about this newly-announced extra-rapid lens, and consequently Mr. Squires had the honour of submitting the lens and specimens produced thereby to his Royal Highness, and the pleasure of hearing the Prince express his unqualified approbation. This is of course a short focus lens, requiring, we are informed, only twelve to fourteen feet between it and the subject to be

depicted ; but we are unacquainted with the peculiarities of its construction, although so far as its form is concerned we presume there is little that is new.

PHYSICS.

New Lantern Polariscope.—A polariscope which is of such a character that it can be adapted to any ordinary magic lantern without involving the expense of sending the instrument to the optician, has just been introduced by Mr. Samuel Highley, of Green Street, Leicester Square. The instrument is figured below. The constituent parts are mounted on a "gout-board support." The upright is fitted with an adjustable panel that carries a bundle of glass plates on one side and the stage and power on the other. When adjusted, the panel is clamped by means of a milled head screw. The bundle consists of such a number of thin glass plates as will give a bright reflected beam of polarised light, and is attached to the panel at the proper angle for producing such a beam. The spring stage for carrying selenite designs, unannealed glasses, pressure, and heating clamps, and the larger objects, is formed within a large tube attached to the front side of the panel ; and to the front of this is screwed a spring jacket, within which slides the power and stage for the smaller crystals employed. To the front part of the face-board an adjustable rod is fixed that carries the analyzer, which consists of a large prism made expressly for the purpose of giving a large and pure field of colour, the absolute field attainable being of course dependent on the intensity of the source of light employed. We believe this was the instrument used by Mr. Highley at the late conversazione at University College, and from what we have seen we can speak in the highest terms of its powers of work.



HIGHLEY'S NEW LANTERN POLARISCOPE.

The Spheroidal Conditions of Liquids at Common Temperatures is now receiving considerable attention, both in this country and on the Continent. Among those foremost in the list of investigators we may mention the names of Meunier and Tomlinson. The latter has written several able

papers upon the question, and appears inclined to adopt the supposition that the spheroidal condition under ordinary circumstances is due to the existence of a layer of vapour which prevents contact between the globule and the surface beneath. This opinion is borne out by the fact that, in damp or wet weather, the duration of the globules is much diminished. There is certainly no contact between the globule and film. This may be proved in several ways :—(1) There is a slight depression in the film, just below the globule, and this depression accompanies the globule when it rolls about as it sometimes does. (2) The drop may fall with some force from the end of the glass rod, as from the height of an inch, and roll about without being absorbed. (3) The glass rod, with the drop hanging from it, may be lowered upon the film several times, so as to flatten the drop, without its being absorbed. In some cases, however, there is contact between the spheroid and the surface beneath at a single point; for in rolling about the spheroid will sometimes leave a trail of liquid, and so diminish in size until it suddenly vanishes by being absorbed. Whether it be rolling about or stationary, the spheroid displays by the rapid motions of its particles the struggle that is going on between gravity and cohesion. If a minute portion of lycopodium powder be shaken over the globule, and this rude treatment does not cause it to break up, the powder will be seen streaming rapidly down the outer surface of the spheroid, and ascending by the central vertical axis to separate again at the top, and stream over the surface again to the bottom—presenting, in fact, a figure something like that given in books to illustrate the boiling of water.—Vide *Philosophical Magazine*, December.

Characters of Drops of Liquid.—From Mr. Tate's article in the *Philosophical Magazine* the following conclusions relative to the magnitude and other characters of drops of liquid may be drawn :—1st, That other things being the same, the weight of a drop of liquid is proportional to the diameter of the tube in which it is formed. 2nd, The weight of a drop is in proportion to the weight of water which would be raised in that tube by capillary action. 3rd, When a drop is formed on a circular surface at a temperature of 50°, the augmentation of weight is in proportion to the diameter of the surface on which the drop is formed. 4th, The weight of a drop of liquid, other things being the same, is diminished by an augmentation of temperature. 5th, Independently of density, the chemical composition of a liquid affects the weight of its drop in a remarkable manner. 6th, When the molecular force of cohesion is greatest, *cæteris paribus*, the weight of the drop is least, and conversely. 7th, In different solutions of chloride of sodium, the augmentation in the weight of the drop is in proportion to the weight of the dry salt in solution.—See *Philosophical Magazine* for March.

Peculiar Properties of Ice.—Professor Tyndall publishes a letter received by him from Professor Reusch, of Tübingen, in which some of the characters of ice not hitherto observed are pointed out. In speaking of the division of particles of ice he writes :—" In dividing these precious plates of ice, I soon found that it was necessary to handle them like glass. If the convex blade of a knife be passed over a piece of ice with a certain pressure, a sharp crack will result, and the plate may be broken in the direction of

this crack, provided that the temperature of the ice and of the air be below 0° centigrade. Obviously the knife acts in this instance like a diamond, which depresses minute particles of glass, and through the wedge-action of which a progressive linear cracking is produced, which renders fracture possible. A mere scratch suffices for neither glass nor ice. It is worthy of notice that these clear sharp cracks are possible in ice which is in contact with water in a warm room—a proof that ice preserves its brittle character at temperatures lying close to its melting point. The breaking off at the crack is on the other hand no longer possible, on account of the regelation in the upper part of the crack.—*Ibid.*

Spectral Characters of Indium.—Messrs. Reich and Richter, the discoverers of this new metal, state that its presence is indicated in the spectroscope by two blue lines, one of which, the brighter, corresponds to division 98 of the scale, and the other to 135. In some cases this mode of analysis becomes unnecessary, as the instant the indium salt is placed in the flame of the Bunsen lamp, it communicates to it a bright violet tinge which they consider to be sufficiently characteristic.

The Real Nature of the "Electric Fly."—The piece of apparatus which bears the latter name has had its history well worked out by Mr. Charles Tomlinson, who has compiled for the benefit of natural philosophers, an account of the various theories held regarding the character of this instrument. Mr. Tomlinson has been led from his numerous experiments to conclude that the theory requires a different expression for an aërial as compared with a liquid di-electric. It seems to have a different action in airs of different densities, and also according as it is wholly or partially enclosed. Its action, when the points are covered, is also distinct, and is equally peculiar in the presence of flame. Hence it may be said that "there is no one expression that fairly represents the electric fly. It modifies its behaviour according to circumstances; and, like a good subject, has no law of its own, but conforms to the laws of the community of which it is a member."—See *Philosophical Magazine*, No. 181.

How to test for Ozone.—Mr. Lowe read a paper some time since before the Royal Society on the above subject. He thinks that the ordinary paper slips are apt to be fallacious, and that they do not indicate the intensity of the action of the ozone. He recommends the employment of the powder tests in preference to the paper slips. By inquiring into the action of various reagents on these powder masses, he has been enabled to draw the conclusion that a new method of investigating ozone is necessary.

Gore's New Furnace.—In our Number for July, 1863, we gave a short notice of a new Patent Gas Furnace by Mr. G. Gore, of Birmingham. The principle of this furnace has since been applied upon a much larger magnitude, and furnaces, on a commercial scale, are now in use at the electro-plate manufactory of Messrs. Elkington, Birmingham, and elsewhere. These larger furnaces, as at present constructed, are capable of melting about 400 ounces of silver, copper, gold, or, if desirable, even cast-iron. The amount of coal-gas consumed in one of these furnaces varies from 300 to 400 cubic feet per hour. With a consumption of 360 cubic feet per hour, the following results have been obtained:—266 ounces of sterling

silver were perfectly melted within twenty-five minutes from the period of lighting the gas in the cold furnace, and the metal was sufficiently hot to cast for rolling in twenty more minutes. A second quantity of 266 ounces of the same metal was then introduced, and was perfectly melted in eleven minutes, with a consumption of 66 cubic feet of gas, value twopence—the price of gas being two shillings and eightpence per 1,000 feet: in a further period of fifteen minutes the metal was sufficiently hot to cast for rolling. A quantity (116 ounces) of German silver was then introduced, and melted in fifteen minutes; and after twenty-eight minutes' longer heating, various highly-figured articles were cast in it, in a most perfect manner. The use of this furnace is extending rapidly, the smaller sizes being much used by dentists, jewellers, analytical chemists, assayers, enamellers, and others, in consequence of their readily fusing silver, gold, copper, glass, and even cast-iron, without the aid of a bellows or lofty chimney, by simply lighting the gas, and the crucible and its contents being at all times protected from the air, and yet perfectly accessible to examination, stirring, removal, &c. The burners of the larger-sized furnaces are formed of a series of plates of cast-iron, and may be readily removed from the furnaces and placed to heat a retort, muffle, reverberatory chamber, or other apparatus where intense heat is required. It is intended to apply them to heating of steam-boilers and welding articles of wrought-iron. The safety of these furnaces, their regularity and self-supplying action, and perfect freedom from dust and smoke, render them advantageous in certain processes, such as enamelling, annealing, &c., where cleanliness and uniformity of heat are required. Their high degree of heat, without the aid of a blast, results from the very rapid and perfect mixture of the air and gas, and the combustion being consequently effected and concentrated in a very small space.

Galileo's Weather-glass.—In the course of the year 1862 a letter appeared in the *Athenæum* describing a very simple form of barometer, which was made by filling a pickle-bottle with water, and plunging into it a Florence-flask with the neck downwards. It was said that, before rain, the water rose two or three inches in the flask, and on the approach of fine weather it fell proportionately. These statements were then contradicted by other correspondents, who asserted that on the approach of fair weather the water rose, and as wet weather neared, it fell. Mr. George Rodwell, F.C.S., now explains the origin of these contradictions. In experimenting upon the influence of the atmosphere on a water barometer of the kind described, he employed a tube with a diameter of $\frac{1}{16}$ of an inch, and a length of 2 feet 11 inches; the bulb was 2 inches in diameter, and contained 68 cubic centimetres of air at 48° Fahrenheit. The open end being placed in a vessel of water, the latter fluid rose in the stem to a height of 12 inches. It was found that increased pressure of atmosphere and simultaneous diminution of temperature caused the water to ascend in the tube. This result took place for the following reasons:—(1) The tension of the outer air was greater than that of the air in the bulb. (2) The air in bulb was contracted by diminution of temperature. (3) The tension of the aqueous vapour in the bulb was diminished. It was found also that, for reasons of a converse nature, the water descended

in the tube when the temperature rose and the atmospheric pressure was reduced. It seemed, therefore, that increased pressure caused the water to ascend, whilst increased temperature caused its descent; so that, whenever both these agencies were at work, the alteration in the height of the water depended upon which of the two was superior. Herein, then, lay the cause of the discrepancies. If the temperature was constant, the weather-glass of Galileo would be a faithful instrument; but as the temperature does not always correspond to the pressure of the atmosphere, the elevation of the water in the stem could not be constantly proportionate to the density of the external air.—See a most interesting article in the *Chemical News*, February 6, 1864.

The Boiling Points of Mixed Liquids are regarded by M. Alluard as being by no means tests of their purity. When ether is mixed with one-tenth of its weight of sulphide of carbon, it boils at the same temperature as pure ether. In order to discover the purity of a liquid, the static and dynamic methods of Regnault's process must be employed. By the adoption of this means, the presence of the $\frac{1}{1000}$th of a substance, added to alcohol or sulphide of carbon, may be detected.—Vide *Comptes Rendus*, lviii. No. 1.

Optical Properties of Azulene.—The latter term is applied to designate the principle contained in two peculiar blue oils, obtained from *Achillea* and *Matricaria*, two genera of the natural order Compositæ. This principle has been submitted to spectrum analysis by Sir David Brewster, who states that the two oils differ from all the various bodies which he has yet examined. Between the two lines A and B of Fraunhofer's map of the spectrum, the two ottoes absorb the light in these portions more powerfully than in the portions adjacent to them. No other fluid or solid upon which he has experimented acts in a similar manner; but what is exceedingly remarkable is the fact, that the earth's atmosphere exerts a similar action when the sun-light passes through its greatest thickness, as at sunrise and sunset.

Temperatures at which Metals boil.—These have been hitherto determined by means of an air pyrometer, but M. Becquerel has adopted another method for their determination. The instrument he employs is a thermo-electric pile, and with it he found that the following metals boil at the following degrees centigrade:—cadmium 720°; zinc 920°; silver 916°; gold 1,037°; palladium 1,360°; platinum 1,480°. It is of some importance to state that certain of these figures are lower than those obtained by M. Becquerel, when using the air pyrometer.—Vide *Comptes Rendus*, lvii. No. 21.

Iron at a high Temperature penetrated by Gases.—M. Cailletet recently laid before the French Academy a *resumé* of his experiments on the permeability of heated metals by gases. He points out that the bullæ or cavities, found in iron, originate in this manner. The gases proceeding from the fire permeate the iron, and occupy the cavities. In order then to prevent the formation of these cavities, it will be necessary to have the fires and metal so related that no vacuum may be formed in the latter.

Luminosity and Temperature of Bodies.—From an extensive series of physical and mathematical researches, M. Provostaye draws the following

conclusions :—(1) All bodies, whether dark, or having a power of reflecting, emit the same calorific or luminous ray, at the same temperature. (2) The quantities emitted, at a given temperature, by various bodies, are proportional to their emissive or absorbent powers for this particular ray. (3) It by no means follows that these rays are sensible to either the eye or the thermoscope, at the temperatures at which they are given off. (4) Nor is it the case that rays of the same kind emitted by two bodies of different absorbent or emissive powers are appreciable at the same temperature.—See *Comptes Rendus*, lvii. No. 25.

Magnetic Storms.—Professor Airy read a paper before the Royal Society, at one of its late meetings, upon this subject. In this communication he proposes a rather peculiar theory in order to explain the nature of these magnetic vibrations. He supposes the phenomena presented by these so-called storms to represent the movements of a magnetic ether, which he thinks is diffused over the entire surface of the globe, so as to constitute an imponderable fluid covering, of several feet in thickness. If then it be supposed that this magnetic ether is subject to occasional currents produced by some action, or cessation of action, of the sun, which currents are liable to interruptions or perversions, of the same kind as those in air and water, we have a theory which is quite adequate to the explanation of all the singular phenomena which those who have devoted themselves to the study of magnetic force are familiar with.

ZOOLOGY AND COMPARATIVE ANATOMY.

Development of the Cranium.—The translation of Professor Rathke's essay upon the Development of the Skull is concluded in the January number of the *Natural History Review*. The learned author gives a series of results as those deducible from his own observations, of which the following are a few :—(1) At the earliest period of fœtal life, the notochord extends posteriorly to the end of the body, and anteriorly to the space between the auditory capsules. (2) The gelatinous mass, which at first lies on the sides of the notochord, eventually embraces it, forming a sheath, which ends in a point behind, but sends out two processes in front. (3) This investing mass is converted into the vertebral column, and a great portion, *but not all*, of the skull. (4) The essential part of a vertebra is the body. (5) From the anterior portion of the investing mass of the cephalic portion of the notochord are developed the basi-occipital, basi-sphenoid, and ethmoid. (6) The basi-occipital constitutes originally, like the body of a vertebra, a sheath round a part of the notochord. (7) The two sphenoids do not agree perfectly with vertebræ in their development, the anterior diverging more widely from the vertebral type than the posterior. (8) Though both sphenoids possess certain characters in common with true vertebræ, the ethmoid is differently circumstanced ; it never embraces a segment of the nervous tube. It no longer offers any special resemblance to a typically-formed vertebra. (9) Thus in regard

to their mode of development, the four basal bones present four gradations; the occipital being most, and the ethmoid least like a vertebra. (10) Of the facial bones, the lower premaxillæ and nasal bones are developed altogether independently of the investing mass of the notochord. (11) Neither the auditory capsules nor the petrosal bones can be regarded as parts of vertebræ, their development proving that they are essentially intercalary.

The Morphology of the Tunicata has been well investigated by that industrious and distinguished anatomist, Dr. John Denis McDonald. He considers that the fixed tunicates belong to two principal types, and the floating ones may be grouped into four typical divisions; and, furthermore, he is of opinion that a decided relationship exists between the fixed and pelagic groups. In his paper, read before the Royal Society of Edinburgh, he states that, while he admits that habits of life cannot always be taken as a character on which to base a system of classification, yet, that, in the case of Tunicata, mode of life affords a simple and natural scheme for the division and classification of the beings included in this group. It is, for example, a strange fact, that in Flustra, the zoïds lie face downwards, and in Botryllus, with the face upwards. This constitutes one of the chief points of difference between the compound tunicates and the polyzoa, and it shows that the latter are related in the same manner to the Brachiopoda, as the compound to the simple tunicata; in other words, as a Gorgonia is related to an Actinia.

Meaning of the Term Anthropology.—Immediately the Anthropological Society was founded, an outcry was raised against its members for introducing a new word into the English language, which, said their opponents, had its meaning already expressed in the well-known word "ethnology." This feeling still exists, and therefore, we are glad to perceive that the learned president of the Anthropological Society has taken the subject of the controversy in hand. At a late meeting (January 5th), Dr. Hunt, in delivering the annual address, observed: "If ethnology means the science of races, then it is assuming what has yet to be proved. Personally, I believe in the existence of races, and, consequently, that there is a science of 'ethnology;' but how objectionable the word must be to those who do not believe in races can be easily conceived. In the word 'anthropology' there is none of these gratuitous assumptions. It assumes nothing, and merely means, the science of man, or mankind. Some men in this country have expressed themselves adverse to the introduction of what they please to call a new word in the language, and also that 'anthropology' means exactly the same thing as 'ethnology.' Both statements are equally erroneous. 'Anthropology' is not a new word, nor does it mean at all the same thing as 'ethnology.' In Germany, France, and even in America, the word 'anthropology' has long been introduced, and with exactly the same meaning which we attach to it. Indeed, I think I may affirm, that there is not a scientific man of any eminence in Germany, France, or America, who now ever confuses the meaning of the two words—'anthropology' and 'ethnology.'"

The Sea Louse of the Baltic.—A remarkably fine specimen of this

crustacean was not long since exhibited by Professor Haughton, to the members of the Dublin Natural History Society. The creature was dredged by the Professor, when yachting off Helsingfors. It was found on a bottom composed principally of decayed fir (its favourite habitat). It certainly seems strange, as Dr. Haughton observed, that with the exception of this animal (*Oniscus entomon*), and a few dwarfed Tellinæ, the Baltic should be so barren a field for the naturalist's dredge. Linnæus observed that the sea-louse frequented particularly those parts of the Baltic which were visited by the shoals of herrings.

Entozoa in the Stomach of the Alligator.—Dr. A. Wynne Foot gives the following interesting account of the condition of an alligator's stomach which had been attacked by nematoid worms. The animal was reported to have been in the habit of vomiting its food before death. The stomach of a globular shape was the size of an orange and distended with air; it contained 115 worms of the genus Ascaris, averaging in length from three to four inches; about one-half of them had spirally convoluted tails; it also contained ten small pebbles and sharp-pointed flints (one of which was seven lines long); three pieces of charcoal (one of which was thirteen lines in length), and a soft pale coagulum with some yellowish viscid mucus which had an acid reaction. The surface of the stomach was covered with a series of irregular deposits of a fine yellowish matter, which were slightly raised and varied in extent from the size of a pea to that of a sixpence. These gave a sensation to the finger such as that produced by rubbing it against firm sand-paper, and even so adherent that they could not be removed without tearing away the subjacent stratum of tissue. The nature of these incrustations is not mentioned by Dr. Foot, so we presume the material composing them was not submitted to chemical analysis. The facts are, however, of some interest.—Vide *Dublin Quarterly Journal of Science*, January, 1864.

Characters of the Male Salmon after it has shed the Milk-fluid.—The distinguished vice-president of the Zoological Society of Ireland, Mr. W. Andrews, has recently given a very admirable description of the male fish after the spawning season, and before it has reached the sea. The specimen, which weighed about 15 lbs. had evidently been detained for some time in the river, having been unable to get a free run to the lake on its course to the sea. It had become exceedingly dark in appearance, of a reddish brown hue, its back and sides being marked and studded with large black and red blotches. The gill covers and head were of an olive brown colour streaked with red, and with large black spots. The remarkable characters were the large and unsightly proportions of the head, in comparison with the size of the body, which although in better condition than would have been supposed, still was much attenuated. On dissection its flesh was found to be sodden and soft, and of a pale or faded pink colour, denoting an extremely unhealthy state. The gills were infested by parasites (the gisler or *Branchiella salmonia*). The still more remarkable character that presented itself was the large size and almost horny consistency that the cartilaginous extension of the lower jaw had assumed, and in such state had it become that the point had forced a

complete passage through the upper jaw through which it passed, probably, at every attempt of the fish to feed.—*Dublin Quarterly Journal of Science*, xiii. p. 50.

Variation of Species among Rhizopods.—Our best authority upon the anatomy and distribution of the animals embraced by the group Rhizopods is Dr. G. C. Wallich. This observer has contributed several valuable papers to the *Annals of Natural History* for the past year, which should be carefully studied by all protozoan-loving naturalists. His last memoir appears in the March number of the Journal alluded to, and in it he enters into a description of the forms and relations of the so-called species of the genus Difflugia. The great bulk of the species are mere varieties of a few definite forms. It seems that in certain species the sarcode matter which constitutes the animal has the power, under different conditions, of building up different tests or shells. Thus, when in the locality in which they are found, one set of minerals is abundant, they select this, and so on. They seem in this particular rather to resemble the caddis worm, whose habits have been so faithfully pourtrayed by one of our lady naturalists, Miss E. M. Smee. The general conclusion which Dr. Wallich draws is thus expressed. *The animal does not vary; but it modifies the architecture of its habitation, and the mineral material of which that habitation is in a great measure constructed in obedience to local conditions, and in the manner best fitted to meet its requirements.*—Vide *Annals of Natural History* for March, 1864.

The Habits of the Australian Tree-Frogs are thus described by Dr. Albert Günther, in an article in the "Annals of Natural History." They sleep during the day, squatting in a corner, generally selecting a place in which they are hidden from view, but easily aroused on the approach of some insect, which they seize with their tongue. When the prey is large, or when they have accidentally seized a small piece of wood, &c., together with the insect, they use their fore-foot to push the insect into the mouth or to remove the object which is unfit for food. They never enter the water during the summer months, and tried to escape from a tank when put into it. They leave their hiding-places towards dusk, becoming very lively, apparently less with the object of obtaining food (which they can only procure by quietly remaining in wait for it) than with that of enjoying themselves. The Australian tree-frog, which is endowed with a voice, indulges every evening in a musical performance. They become more quiet after midnight, and at sunrise they settle down in some resting-place, sometimes one individual selecting the same place for several consecutive days. They prefer bluebottle-flies to every other insect, and never touch ants or black-beetles. They feed freely on meal-worms when other food is scarce; but as they are frequently vomited, it is doubtful whether they could be kept in good health if restricted to this particular form of food. There is now in the gardens of the Zoological Society a collection of eight specimens of these Batrachia, which have been referred by Dr. Günther to the genera *Hyla* and *Pelodryas*, the latter being the best known form. The species are *P. cæruleus* (the Australian tree-frog), *H. peronii*, *H. krefftii*, and *H. phyllochroa*.—*Ibid.* No. 75.

Sub-cutaneous Orifices in the Head of the Eel and Conger.—Many comparative anatomists have been puzzled to know the relations of the sense capsules in fishes, and perhaps there are none of more interest than those of Dr. McDonnel, of Dublin, on the *lateral line* in these animals. A recent investigator, the Rev. W. Houghton, adds his quota to the mass of evidence already existing on this subject. While engaged in the dissection of eels and congers he observed the constant presence of two sub-triangular openings in the fleshy portion of the head, at the point of union of cranium and spinal column. These he at first supposed to be special auditory organs, but he now leaves the question for the decision of other anatomists. He denies the assertion contained in Mr. Pennel's treatise, that these fish have an external auditory aperture in the head; and then goes on to describe the orifices which he observed. Upon placing a bristle in each of these openings, it was found to traverse a closed-in duct in the cranium, and to make its exit just above the orbital bone. These tubes have no connection with either the vestibular sacs or the auditory nerves. He believes these canals to be connected with the so-called mucous system, but in what manner he is not aware.—Vide *Pamphlet*, reprinted from *Quarterly Journal of Microscopical Science*, January, 1864.

Homologies of Insects and Crustaceæ.—Mr. Dana has constructed a very simple diagram showing the nature of the homological relationship between decapods and insects. By glancing at the sketch accompanying his memoir, it will be apparent that the following conclusions, at which the author has arrived, are correct:—(1) The insect wants the three posterior segments of the crustacean. (2) The head and thorax of the insect embrace the same number of segments as the head alone of the decapod. (3) The head and thorax of the insect contain half of its entire number of segments (eighteen); the head and thorax of the decapod contain two-thirds of the whole (entire number twenty-one). (4) The head of an insect contains six segments, which is one-third of the whole number; that of a decapod nine segments or *three-sevenths* of the whole. (5) The segments connected with the organs of digestion are the tenth, eleventh, twelfth, thirteenth, and fourteenth in both insect and decapod. But in the insect the tenth is the first behind the thorax; and in the crustacean it is the first behind the head. It is very questionable whether Mr. Dana is correct in assuming the presence of the three anterior segments in the insect as distinct parts. If we suppose them to be present, the difficulty of showing the homologies is much diminished.—See the *Annals of Natural History* for January.

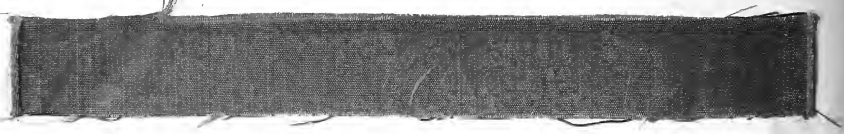
Structure of the Animal Substance of Difflugia.—In Mr. Carter's memoir on the fresh-water rhizopods of England and India, which appeared in a late number of the *Annals of Natural History*, the author describes the appearances seen with the microscope when the test and animal of Difflugia compressa were crushed under a glass cover. The animal-matter consists of protoplasm embedding, small brown cells, oil globules, starch granules, and reproductive cells. The first are globular in form, about the $\frac{1}{6000}$ of an inch in diameter, and appear to give the creature its light brown colour. The second are more abundant, vary in size, and under the

influence of iodine they lose their colour and become more brilliant and refractive. The third forms always carry a nucleus, which in its turn possesses a nucleolus, the latter being disk-like in shape, while the former is a spherical cell. The fourth series of morphological elements, the reproductive cells, are of an oval or circular shape, filled with homogeneous contents, colourless, more or less refractive, about $\frac{1}{200}$ of an inch in diameter, but occasionally twice as large. Their number is not constant, but varies from ten to twenty, or more, and they have been frequently observed both with and without the nucleus in its spheruliferous state. When iodine is added to them, they become tinged with an amber hue, and occasionally present granular contents ; a claret hue is sometimes produced by this re-agent, but this is never of so deep a colour as to render the bodies liable to be mistaken for starch granules. Mr. Carter also alludes to the presence of chlorophyll cells, and seems to imply that these latter are identical with the *granules* of Amoeba, and the amoebous cell of Spongilla.

The Law of the Production of the Sexes in Animals.—Professor Thury's memoir has been partly translated by Mr. W. S. Dallas, F.L.S. It is already known to most of our readers that the former naturalist lately advanced some very peculiar views as to the question, How are the different sexes produced. He believes that the earlier ova formed in the ovaries of all animals are in an imperfect condition, and if in this state they be fertilized, the result will be the production of a number of females ; if, however, the act of fecundation be delayed, males only will be developed. Hence he assumes that, among mammals, if the fertilization of the ovum occur at the commencement of the rutting season, females will be produced ; if at the termination of this period, males only. It would appear that his doctrine has been corroborated by the results of several experiments. For our own parts, we are extremely sceptical as to the truth the discovery ; nevertheless, as they may be of interest, we give the following series of "practical observations," which constitute the second portion of Professor Thury's memoir :—(1) Sex depends on the degree of maturation of the ovum at the moment of its fecundation. (2) The ovum which has not attained a certain degree of maturation, if it be fecundated, produces a female ; when this degree of maturation is passed, the ovum, if fecundated, produces a male. (3) When, at the rutting season, a single ovum separates from the ovary to descend slowly through the genital canal (as in uniparous animals), it is sufficient that the fecundation takes place at the commencement of the rutting season to produce females, and at the end to produce males—the turning point of the ovum occurring normally during its passage through the genital canal. (4) When several ova separate successively from the ovary during a single generative period, the first ova are generally the least developed, and produce females ; the last are more mature, and furnish males. But if it happens that a second generative period succeeds the first one, or if the external or organic conditions change considerably, the last ova may not attain to the superior degree of maturation, and may again furnish females. Hence it happens that the application of the principle to animals which are multiparous is far from easy. (5) In carrying out experiments it will be necessary to be

perfectly certain as to the period at which the rutting function commences. (6) As animals living in a state of confinement do not exhibit this phenomenon in a very regular or normal manner, they should not be selected for experimentation; and animals which live in a state of freedom should be employed. (7) From the mode in which the law ruling the production of the sexes has been deduced, it results that this law must be general, and apply to all organized beings—that is to say, to plants, animals, and man.—Vide *Annals of Natural History*, January, 1864.

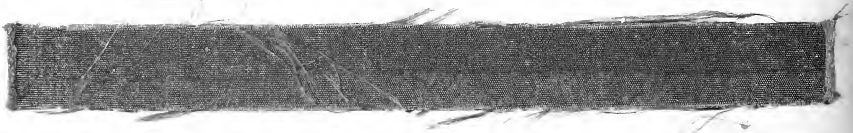
NATURAL HISTORY.



Aniline Blue, called "Opal Blue." (See p. 437.)

Chrysaniline, or "Phosphine." A residual product.

Rosaniline, or Roseine. (See p. 434.)



Hofmann's Patent Violet.
Obtained by acting upon Rosaniline with iodide of ether.

Regina Purple. A residual product.

Imperial Violet.
Obtained like the "Opal Blue," by acting upon Rosaniline with Aniline.

ANILINE DYES.

THE ANILINE DYES.

BY DR. T. L. PHIPSON, F.C.S.,

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IT has been whispered to me that a popular history of the new Aniline Dyes would fill a gap that has hitherto remained wide open in the scientific literature of the present day. In taking up my pen to compose such a history, I would be allowed to remark, by way of preface, that the following lines are not intended for the philosophical transactions and the aristocrats of science, but for the POPULAR SCIENCE REVIEW and the Garibaldians of philosophy. In all matters connected with chemistry it is best to be as brief as is consistent with explicitness, and to avoid anything approaching to grand phrases or "sensationism;" therefore I shall offer no apologies for roughness of style or for attacking the subject in a straightforward manner.

As the only thing I happen to have done myself in connection with aniline was the discovery of this curious compound in the vegetable world, I shall take Dr. Hofmann in my right hand and Messrs. Simpson, Maule, & Nicholson in my left, combining theory and practice, whilst travelling over one or two of the most beautiful and luxuriant pages of modern chemistry.

It may seem wonderful that, to arrive at the brilliant colours which serve to illustrate this paper, we must start from coal; for it is among the products of the distillation of coal that we find the substances capable of yielding these magnificent dyes. In ordinary language the word *distillation* applies to liquids only, but in chemistry it is equally applicable to any substance which, being placed in a close vessel and heated, gives off vapours which distil. Now, if instead of water or spirit we put a solid piece of coal into a retort and apply heat, the following phenomena invariably occur: a considerable amount of combustible gas is evolved; this is no other than the gas which lights our streets, and whilst it is produced a large amount of tar and watery vapour distils and passes out of the retort. When the operation is finished, that is, when no more

gas or oily products (tar) are produced, there remains in the retort a fragment of coke.

All the products of this splitting up of coal by the action of heat have been largely utilized; they have given rise to extensive and most important branches of industry and promise to yield still further benefits to mankind. In former years coal was looked upon as a species of carbon; but it was soon discovered to be a substance rather more complex in its nature than had been imagined:—100 lb. of coal contain on an average 80 lb. of carbon, 5 or 6 lb. of hydrogen, 2 lb. of nitrogen, 5 to 12 lb. of oxygen, $\frac{1}{2}$ to 1 lb. of sulphur, and 5 to 10 lb. of mineral substances which constitute the *ash*; it leaves in a retort after distillation about 60 per cent. of coke.

Any person who has devoted a little attention to organic chemistry will see at once what a vast number of products may be formed by the grouping together of these elements in various ways. Now, when coal is distilled no less than fifty-one distinct substances are obtained from it; that is, fifty-one distinct substances have hitherto been discovered in the products of the distillation of coal, maybe others will shortly turn up. Practically speaking, these substances are not of equal importance. Among those which demand our more particular attention here are: 1st., the gas which serves to light our streets. This is chiefly marsh-gas, the gas which bubbles up from the mud of stagnant ponds, otherwise called protocarburetted hydrogen, C^2H^4; containing also some bicarburetted hydrogen, C^4H^4; and carbonic oxide, C O; a little free hydrogen, H; sulphuretted hydrogen, S H; carbonic acid $C O^2$; acetylen, C^4H^2; &c. 2nd, the oily products or tar from which we obtain a variety of hydrocarbons, boiling and distilling at different temperatures, such as benzol $C^{12}H^6$, toluol $C^{14}H^8$, which are liquid; naphthaline $C^{20}H^8$, and paraffine (the composition of which is uncertain) which are solid; besides creosote or phenol, aniline, ammonia, and several other similar substances. 3rd, The coke which remains in the retort. The latter we will dispose of at once by stating that it is extensively used as a combustible, and also as a powerful element in certain forms of electric batteries. Not many years ago the oily products or tar were likewise burnt under the retorts of gasworks in order to economise the coal. Very different are the uses to which they are applied at the present day!

This is not the place to examine the best methods of producing and purifying gas for illumination, nor to allude to the enormous amount of sulphate of ammonia annually produced for agricultural purposes by causing this gas to pass through sulphuric acid on its way to the gasometers. We must fix our

attention here upon the oily and tarry products which condense in the hydraulic main and other condensers through which the gas must pass on its way from the retorts to the gasometers. This *coal-tar*, as it is called, on being put into a retort and distilled again yields different products at different temperatures, so that by a kind of fractional distillation we obtain two varieties of "coal-oils;" the *heavy-oils* which are heavier than water, and the *light-oils* which float upon water. The former are black and have a powerful odour; they are extensively used to prevent the decay of railway sleepers, piles of bridges, palings, and other similar wooden constructions, on account of their powerfully antiseptic properties. In the hospitals of Paris I have seen them recently employed in the treatment of ulcerated wounds, for which purpose they are mixed with gypsum to solidify them a little, and to modify the intensity of their action.

The *light-oils* constitute a thin combustible liquid known as coal-naphtha, which is distilled again to obtain Benzol. Lately, however, it has been attempted to distil the heavy-oils also, in iron or earthenware retorts, so as to decompose them into gas for illumination, and volatile oils rich in benzol.

Analyses of several specimens of these heavy-oils which I made last year for the English Government show that they contain on an average :—

Creosote and phenol	1·37
Naphthaline	19·76
Brown oil	48·62
Pitch	30·25
	100·00

On being distilled they yield a large amount of naphthaline by *decomposition*, as well as other products, and *if run into hot retorts they yield much carburetted hydrogen gas and Benzol.*

This Benzol, then, is the starting-point in the manufacture of the aniline dyes; for, the aniline that exists already formed in the coal-oils is in too small a quantity to admit of its being extracted with economy; whereas benzol is easily produced, is manufactured on a very extensive scale, and furnished to commerce at a low price. Without benzol we should have no aniline dyes, no beautiful mauve and magenta or rosaniline; but as benzol can be produced wherever there is coal, there is no fear of our being deprived of these vivid colours for many centuries to come.

It has been believed that the famous Tyrian purple of the ancients is extinct,—like the Dodo, &c. Such is not a fact.

We are at liberty to produce as much Tyrian purple as we like; but we should probably not obtain it as the ancients did from the whelks and other sea snails whose history, in this respect, I have sketched in my recent work, "*The Utilization of Minute Life, &c.,*" but from guano. For, if the purple of the ancients was not derived from murexide—a substance we can obtain by means of the uric acid contained in Peruvian guano—murexide will produce the purple derived from the whelks. But this purple is far inferior in brilliancy to the aniline purples of the present day, for the art of producing colours, like everything else in nature, is subject to the law of progress!

To return to benzol, the history of this substance is by no means devoid of interest. It was first obtained in 1825, by Professor Faraday—who little dreamt of the future uses to which it would be applied—whilst studying the products derived from the distillation of vegetable oils, and described by him as a liquid hydrocarbon. In 1834 the celebrated chemist Mitscherlich of Berlin obtained the same substance by distilling benzoic acid in presence of excess of lime or baryta, and called it benzol. Some French chemists afterwards called it *Benzine*. It is not difficult, on comparing Faraday's paper with that of Mitscherlich, to perceive that they had both produced the same substance. Some time afterwards it was found that benzol exists in considerable quantity in coal-tar naphtha, *i.e.*, in the light oils from the distillation of coal, which float on water, boil below 100° centigrade, and congeal to a solid mass at *zero*. The way of obtaining benzol by distilling this coal-tar naphtha appears to have been first pointed out by an English chemist, Charles Mansfeld, who died at an early age soon after publishing an ingenious pamphlet upon benzol and its economic applications. The idea, like so many others, was soon *exploitée* on the Continent, where, about 1850, impure benzol was sold about 2 francs per pint under the name of benzine-collas for cleaning gloves, tissues, &c., as it has the power of easily dissolving grease.

The properties of benzol are soon told. It is a hydrocarbon $C^{12}H^6$, liquid at ordinary temperatures and colourless, solidifying into a crystalline mass at *zero*, boiling at 80° centigrade, having a specific gravity = 0·85, therefore floating upon water, in which it is quite insoluble, but dissolves in alcohol and ether. It has generally a strong odour of naphthaline or coal gas, but when quite pure its odour is more aromatic and less powerful. Pure benzol is not discoloured by strong sulphuric acid. But the most remarkable property of benzol resides in its action upon nitric acid. Other acids do not attack it readily; but with concentrated nitric acid, aided at the commencement of the action by a slight heat, a new sub-

stance is formed called nitrobenzol. Nitrobenzol only differs from benzol by the latter having one of its equivalents of hydrogen replaced by one equivalent of hyponitric acid, thus :—

$C^{12} H^6$	$C^{12} H^5, NO^4$
Benzol.	Nitrobenzol.

If benzol be added to warm nitric acid by degrees, and as long as it dissolves in the acid, a dark red liquid is obtained, and when water is added, nitrobenzol falls to the bottom of the liquid as a heavy, yellow, oily substance, insoluble in water, capable of crystallising in long needles when exposed to a cold of $+3°$ centigr., and having a very pleasant odour of essence of almonds. This odour has caused it to be somewhat largely employed in place of the more expensive essence for scenting soaps, &c., for which purpose it has been sold for some years under the name of "essence of mirbane."

Nitrobenzol brings us another step nearer to the aniline dyes; for it is from nitrobenzol that all the aniline of commerce is prepared. This transformation of benzol into nitrobenzol was also discovered by Mitscherlich, but the formation of aniline from nitrobenzol was first effected by Zinin, of St. Petersburg. This curious change is brought about by the substitution of 1 equivalent of amide $N H^2$ for the equivalent of hyponitric acid $N O^4$, in nitrobenzol, thus :—

$C^{12} H^5, N O^4$	$C^{12} H^5, N H^2$	or $C^{12} H^7 N$
Nitrobenzol.	Aniline.	

Such a change is effected when nitrobenzol is acted upon by nascent hydrogen, when all its oxygen unites with this hydrogen to form water, and aniline is the result. This occurs best when nitrobenzol is mixed with acetic acid and iron-filings; the three substances being mixed in a retort, and a gentle heat applied, aniline distils, and can be collected in a cooled recipient. It is a liquid of an oily appearance, falling to the bottom of a glass of water, and producing a vivid but evanescent purple blue colour when mixed with a little chloride of lime on bleaching powder.

It should be remarked here, that aniline has been discovered by Fritsche, of St. Petersburg, in the products derived from indigo, when this colouring matter is acted upon by potash. It was met with in the products of the distillation of organic bodies, by Unverdorben, who described it under the name of crystalline; it has also been described by Runge, Hofmann, and others under a host of names. We will not stay here to write its biography, which would lead us too far. It will be sufficient to note that aniline is an organic base, an alkaloid, closely allied to the liquid alkaloids nicotine

(from tobacco) and conine (from hemlock). Like these, it unites with acids and forms salts of aniline, which are soluble in water, whilst aniline itself is very slightly soluble in this liquid. For the rest, it is colourless, has a strong and peculiar odour, mixes easily with alcohol and ether, and decomposes slowly in contact with the air.

We have seen that one of the characteristics of aniline is to produce with bleaching powder, or, in fact, with any other oxydising agent—a magnificent purple blue colour, which, however, soon disappears again. It was in endeavouring to produce this purple blue in a permanent form that Mr. W. Perkin first obtained, in 1856, the well-known mauve dye. The discovery of the aniline dyes was thus made in England. Mr. Perkin took the sulphate of aniline, more or less pure, and (to oxydise it) mixed it with a solution of bichromate of potash acidulated with sulphuric acid. In ten or twelve hours a blackish looking powder was deposited; this was collected upon a filter, washed with water, and afterwards digested with coal-naphtha, to purify it. It was then dissolved in wood-spirit (methylic alcohol), and when this solution was evaporated it yielded the new dye in a pure state. So great is its colouring power, and so rich the tint produced, that $\frac{1}{10}$ of a grain of mauve dye will colour substantially a whole gallon of alcohol! Until lately it was, weight for weight, as valuable as gold. Mr. Perkin has recently communicated to the *Proceedings of the Royal Society* an elaborate paper upon the composition of this mauve dye. It appears to consist essentially of *mauveine*, $C^{54}\,H^{24}\,N^4$, a powerful organic base, uniting with acids like rosaniline, whose composition we shall see presently. Dr. Hofmann has also published, in the same journal, a numerous series of papers upon the nature and composition of the aniline dyes in general.

Dr. Hofmann appears to have been the first to produce aniline red (magenta, rosaniline, fuchsine) as a scientific curiosity. He obtained it by acting upon aniline with strong nitric acid, and although this process has since been adopted in some manufactories, Professor Hofmann did not make any use of his discovery. The first patent taken out for the production of rosaniline was that of Messrs. Verguin & Renard, of Lyons, who obtained the colour by the action of bichloride of tin upon aniline. Since then many patents have been granted for obtaining different shades of aniline dyes by different processes, and great success in the production of these marvellous colouring matters has attended, in this country, the energetic efforts of Messrs. Simpson, Maule, & Nicholson. We must here pause for an instant to refer to some curious results lately obtained by Dr. Hofmann, which

appear to clear up a mystery that has hung over the production of aniline dyes in general. It will be seen from what precedes, that the colours in question are produced whenever aniline is submitted to the action of *oxydising agents* (chloride of lime, nitric acid, bichloride of tin, bichromate of potash, ozone, &c.), and according to the particular *oxydiser* we make use of, we obtain one shade or another: hence a considerable number of patents; hence also several severe law cases, &c. It passed, then, as a fact, that when aniline was oxydised it gave magenta. One morning, however, not many months ago, Dr. Hofmann took some *pure* aniline and found that it gave no magenta whatever! It is known that commercial aniline always contains toluidine—another base very similar to aniline, and produced exactly in the same manner. In coal naphtha along with benzol $C^{12}\,H^{6}$ we find toluol $C^{14}\,H^{8}$, so along with nitrobenzol $C^{12}\,H^{5}$, $N\,O^{4}$, we obtain nitrotoluol $C^{14}\,H^{7}$, $N\,O^{4}$, and along with aniline $C^{12}\,H^{7}\,N$ we get toluidine $C^{14}\,H^{9}\,N$. In fact, the benzol, nitrobenzol, and aniline of commerce are mixtures of the bodies just named, in various proportions, and whose boiling points differ almost in every sample; for whereas benzol boils at 80°, toluol only boils at 108°; aniline (pure) at 182°, toluidine (pure) at 198°.

It was natural, then, that Dr. Hofmann should take pure toluidine in making his next experiment; but still he obtained no rosaniline! As a last resource, he mixed the two substances aniline and toluidine together, when, upon submitting the mixture to the action of an oxydiser, he immediately obtained the dye. What appears to happen is this: 2 equivalents of toluidine and 1 equivalent of aniline are acted upon together by the oxydiser, lose by its action 7 equivalents of hydrogen, and give rosaniline—

$$2\,C^{14}\,H^{9}\,N + C^{12}\,H^{7}\,N = C^{40}\,H^{25}\,N^{3}$$

Toluidine. Aniline.

and—

$$C^{40}\,H^{25}\,N^{3} - 7\,H = C^{40}\,H^{19}\,N^{3}$$

minus Hydrogen. Rosaniline.

So we see that it is not the *purest* samples of commercial aniline which furnish the aniline dyes. Pure aniline, as already noticed, boils at 182°; but the manufacturers of dyes prefer anilines which boil from 185° to 210°. It is more than probable that in commercial aniline we have several other substances present besides toluidine, and whether these affect the colours in any way remains to be determined.

We have seen how mauve or aniline purple is produced, let us now turn to the production magenta, rosaniline, or aniline crimson. If we heat a little aniline in a test tube with

bichloride of tin, bichloride of mercury, for instance, we get immediately the splendid aniline crimson known by so many fancy names. Its colouring power is as intense as that of mauve noticed above. Mr. Nicholson has obtained this colour in its pure state, and it has been submitted to analysis by Dr. Hofmann and others. Like mauveine, it is a powerful base, having for formula $C^{40}\ H^{19}\ N^3$, generally containing, moreover, 2 equivalents of water, and then slightly coloured; but *in its absolutely pure state, it is colourless.* It is called rosaniline in chemistry, and on uniting with acids forms well-characterised salts, crystallising perfectly, and possessed of the vivid crimson colour which constitutes the dye.* Thus the magenta dye is always a salt of rosaniline, pure rosaniline itself being devoid of colour, or nearly so. The hydrochlorate of rosaniline is $C^{40}\ H^{19}\ N^3$, H Cl; the acetate of rosaniline was exhibited in the shape of a crown of beautiful crystals in the Exhibition of 1862, by Mr. Nicholson: this mass of crystals valued about £100 sterling.

If we inquire how it happens that so expensive a substance can have become so soon the object of an important manufacture, we find it is simply because a very small quantity of rosaniline goes a very long way as a dye. Moreover, nothing is simpler than the operation of dying with this substance. Silk or wool thoroughly cleaned has only to be plunged into a solution of mauve or magenta, taken out and washed. The dye is fixed in an instant, no previous preparation nor mordants are required. Not so, however, with linen, cotton, paper, or *vegetable* substances; upon these the dye has no hold unless they have been previously coated with gluten or some other nitrogenous or animal substance: it is upon *animal* fibres, such as silk and wool, that the aniline dyes adhere so easily; hence they readily stain the fingers of the operator.

Rosaniline is produced when commercial aniline is acted upon by bichloride of tin, bichloride of mercury, arsenic acid, nitric acid, perchloride of iron, &c. Most of these different processes for obtaining modifications of the same substance have been made the objects of numerous patents. MM. Laurent & Casthelez have recently succeeded in converting nitrobenzol directly into aniline red by heating it with a mixture of iron and hydrochloric acid, or with protochloride of iron. In this process aniline is produced during the operation, and also perchloride of iron. When the mixture is heated, this perchloride reacts on the aniline to form the crimson dye.

* It will be remembered that Preisser, in an ingenious paper published some years ago, showed that most colouring matters are, in the pure state, as colourless as white sugar.

We have a yellow aniline dye called chrysaniline, the composition of which is represented by C^{40} H^{17} N^3. It is obtained from the residue which remains after the extraction of rosaniline. This residue is submitted to a current of steam, which carries off the yellow dye. When nitric acid is added to the condensed liquid, the chrysaniline is precipitated as nitrate of chrysaniline. This salt is so insoluble in water, that nitric acid may be precipitated from a weak solution, by adding a little hydrochlorate of chrysaniline, a more soluble salt.

The beautiful blue aniline dye is obtained by heating for some time a salt of rosaniline with an excess of aniline, at a temperature ranging from 150° to 160° C. The rough colour thus produced is purified by washing with boiling water, &c. It is soluble in spirit, and may be obtained in crystals of a copper-metallic appearance. We have also a green aniline dye, called emeraldine, yet little known and not very fine; also various shades of red and purple, and a black aniline dye, which we have not space to notice here.

Specimens of the principal aniline colours at present produced, and in use, have been kindly furnished to me by Messrs. Simpson, Maule, & Nicholson, to illustrate this paper. Their superior brilliancy over all other dyes will be easily seen by approaching near to them a similar piece of silk dyed with any other colouring matter. Almost all dyes are more or less affected by sunlight: some are more brilliant when prepared in the sunshine than when prepared at night; others quickly fade by the action of the sun's rays. The aniline dyes are not exempt from this *actinic* action (so useful to the photographer, so prejudicial to the dyer); some specimens fade quicker than others, demonstrating the necessity of producing these dyes as pure as possible. The composition of the beautiful aniline blue has been established by Messrs. Nicholson and Hofmann: it is very remarkable. Its formula is C^{76} H^{31} N^3; it is rosaniline in which 3 equivalents of hydrogen are simply replaced by 3 equivalents of phenyle, C^{12} H^5. It has since been found that the other radicals—ethyle, methyle, amyle—may be substituted for phenyle, and give the same splendid blue colour. This is effected by acting upon rosaniline by the *iodides* of these radicals; and as a demand has suddenly arisen for iodine for this purpose, the price of that metalloid has risen considerably of late.

I think enough has now been said to show, in a general manner, how the aniline dyes were discovered, how they are produced, what is their chemical composition, and how a considerable commercial value may, sooner or later, attach to what was, in the origin, a purely *scientific curiosity*.

ON THE ACTION OF MANURES.

BY BARON LIEBIG.

NO one will maintain that it is a matter of indifference to the husbandman, whether the ideas or principles which guide him in his operations are true or false. The success of his practice is evidently based on two things—that he knows what he is doing, and that he does the right thing in the right way; so that, as every scientific view in agricultural matters becomes in its application a money question, it may perhaps be of interest to him to learn the exact state of our knowledge respecting the principles and theory of manuring.

Science has taught us that plants require for their normal growth a number of elements (carbon, phosphorus, silica, ammonia, potash, lime, magnesia, &c.), most of which are furnished by the soil; and it has been established by the direct experiments of Stohman and Knap that these various nutritive substances possess an equal nutritive value—that is to say, that all must exist together and work together in the building up of the vegetable fabric in its normal condition. Taking the case of those plants which supply food for man or beast, it is found that in the process of their nutrition none of these different substances can replace or discharge the functions of another; so that, if one be wanting, although there may be an abundance of the rest in the soil, the plant cannot grow; if one of them be insufficiently represented in the soil, the harvest will suffer in a certain proportion to the element that is wanting; ammonia therefore possessing no higher nourishing or manure-value than lime, phosphoric acid no higher value than potash, &c.

This doctrine, based on natural laws, is not generally admitted by English farmers, and has even been stated to be inapplicable to English soils. Starting from the result of a number of experiments made on a small piece of ground, a manufacturer of manure in London maintains, that there are degrees in the value of each of the nutritious elements in a manure, which could be easily determined, or estimated by the amount of crops produced on any field after being manured with it.

If the produce were increased by one element and not by another, he concluded that the first possessed a preponderating value over the second.

In his trial fields, for instance, phosphoric acid had little or

no effect in increasing the corn crop; whilst, on the other hand, by manuring with the same phosphates a turnip field, a much larger crop of roots was produced than on a field unmanured.

In manuring with salts of ammonia the result was reversed; the corn crop being increased by them, but no perceptible effect being produced on turnips.

A so-called practical doctrine was derived from these facts; they proved, it was said, that nitrogen (ammonia, nitric acid) was an especially efficacious ingredient in manure for corn, and phosphoric acid equally so for turnips.

The specific efficacy of ammoniacal salts on corn was further shown by the fact, that a field manured for several years with them alone produced equally large crops of corn during that time, and likewise, in a very striking manner, ceased on the third year to yield a crop of turnips. The great efficacy of super-phosphate of lime on turnips was shown by the other fact, that a field which, unmanured, gave no more turnips on the third year, produced nine crops, one after another, when this manure only was applied.

Now, a very slight reflection is sufficient, I think, to show us that this mode of testing the efficacy of the several nutritious elements of plants is idle and useless; for if it be once proved, as an empirical law, that ammonia, phosphoric acid, potash, lime, &c., are nutritious elements, and as such indispensable for all plants, there can be no further doubt of their efficacy in any single case, and no additional proof of their utility or value will therefore be needed. If, by manuring a corn field with salts of ammonia, or a turnip field with super-phosphate, the crops of corn or of turnip-roots be increased, the fact is not in the least wanted to prove the efficacy of those manures, which is already known and undisputed; nor if, by manuring a field with potash or lime, &c., no increase of crop be observed, does it therefore follow that these substances are not in themselves efficacious.

It is easy to understand that phosphoric acid, or ammonia, may not, either alone or together, exert the slightest influence on the growth of a plant. Supposing phosphoric acid, potash, lime, magnesia, silicic acid, &c., to be indispensable conditions for the efficacy of ammonia, and supposing ammonia, potash, lime, silicic acid, to be indispensable conditions for the efficacy of phosphoric acid, it follows that if a wheat field manured with ammonia alone gives a higher return than it does without it, all that is proved is that this field contained an excess of phosphoric acid, potash, lime, &c., inefficacious because a certain proportion of ammonia was wanting, but rendered efficacious by increasing the quantity of ammonia in the soil; while without this excess of available but not efficacious

elements, the largest manuring with ammonia would have had no effect. In like manner it is perfectly plain, that if a field be deficient in potash, of which turnip roots want ten times as much as they do of phosphates, supposing the available quantity of potash be only sufficient for the formation of three crops, then only three would have been obtained, and the largest dressing with superphosphate could not produce nine.

Experiments of this kind indicate only what elements of food are abundant or wanting in the soil, and it is impossible to prove by them anything about the efficacy of a manure element. The increase or non-increase establishes only the quality or nature of a field, the knowledge of which is undoubtedly very useful to the owner of the land, but to him alone; for it is of no avail to his next neighbour, if the quality of this neighbour's land happens to be different.

Numberless experiments of the same character have been repeatedly made in Germany at the instance of several agricultural societies. On many corn fields manuring with ammonia salts had not the slightest effect, while super-phosphate of lime alone produced much larger corn crops than any other manure had afforded. It is really astonishing that farmers, who call themselves men of experience, can be made to believe that because a manure has produced on a field in a certain country a high return of corn or roots, it should produce an equal effect, and possess an equal value, on all the fields in Great Britain; for, if the efficacy of a manure, A, be believed to depend on the presence and quantity of the manure B, C, D, &c., it must be assumed that all the fields in a country or land contain the same quantity of B, C, D, &c. Now, it is an indisputable fact, that there are scarcely two fields of the same country, often not two fields on the same farm, which possess the same identical geological, chemical, or mechanical character; so that the quantity of the manures B, C, D, &c., varies in each instance. It must be plain, therefore, that the same quantity of manure, A, be it ammonia, phosphoric acid, or potash, must necessarily have quite a different operation in proportion as the fields are differently constituted. Even stable-dung, which contains all the nutritive elements in conjunction, produces different effects when applied in the same quantity to different fields.

With reference to practical farming, it is important to remark, that it follows as a corollary from the law of equality of nutritive value belonging to the constituents of food, that the element or elements, which are either wanting in the soil, or are contained in it in insufficient quantity, are the ones which will prove of preponderating value in the manures applied.

THE OLD RED SANDSTONE FISHES OF ENGLAND.

BY E. RAY LANKESTER.

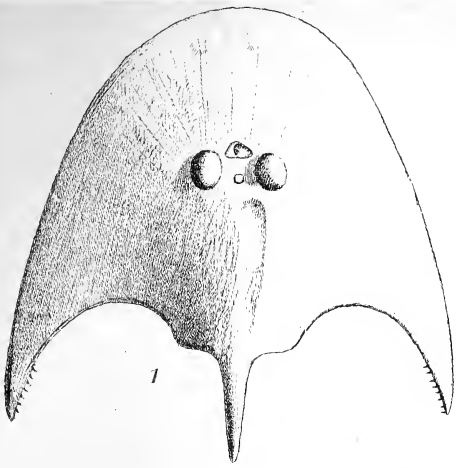
THE majority of our readers, no doubt, are acquainted with the charming works of the late Hugh Miller, in which he described with the pen of a poet and, at the same time, with the mind of a philosopher, the curious fossil remains which were found among his native hills. In fact, the Old Red Sandstone fishes of Scotland were described and illustrated by him in such a way that they have a world-wide fame, and every museum has its fish from Cromarty, its Pterichthys and Coccosteus. It is undoubtedly true that these two last-named fish were remarkable creatures, and their discovery alone was sufficient to attract the universal attention of the geological world. But meanwhile we should not forget that the old Red Sandstone system occurs in other localities besides Scotland, and that fish are found in our English rocks of that period as well as in the Scottish localities. We propose in the following pages to give a very brief account of the English fishes of the Old Red Sandstone; and they certainly have as much interest attached to them as their northern neighbours. The beds which furnish the fish nodules in Scotland belong to a newer period than the English rocks of which we are about to speak, although included by geologists under one and the same denomination as Old Red Sandstone. Over a large part of Herefordshire, and some part of Worcestershire, a very dense and compact sandstone is worked, which is called by the quarrymen and countryfolk "Cornstone." This Cornstone is the lowest member of the Old Red Sandstone series: if we pass below it we come upon the "passage beds" between the Old Red and the Silurian systems; and in some parts of Herefordshire, in railway cuttings and such-like places, where the strata have been tilted, we can pass from one to the other in a few steps. The equivalents of the Scotch beds are sometimes to be found overlying the highest portions of this "Cornstone" series; but, curious to say, they contain no fish. At one locality, Farlow, by great perseverance in search, a miniature species of Pterichthys was detected in these beds; but in England it appears that we are destitute of that great variety of species which characterises the same beds in Scotland. On the other hand, in those rocks which correspond to our Corn-

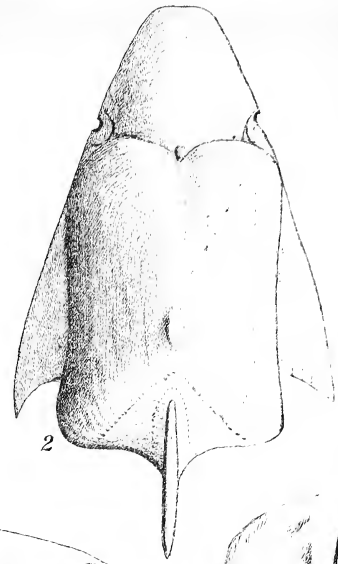
stones in Scotland, and underlie the fishbearing strata, a few specimens are obtained of one species of the three genera we are about to describe; but they are far from being so abundant as they are in the "Cornstones" of Herefordshire. So much for the strata of England and Scotland—the fish which belong to the Lower Old Red Sandstone of England in which we may include the "passage beds" spoken of above, are of three genera, the species being not yet satisfactorily determined. These are Cephalaspis, Anchenaspis, Pteraspis. It must be understood that no species of these genera have yet been found in the higher beds of Scotland, nor have any of the species of the higher Scotch beds been found in the lower English beds—the upper and lower groups are quite distinct. The three genera, Cephalaspis, Anchenaspis, and Pteraspis, together form a family called the Cephalaspidæ, since they all bear some resemblance in external form to one another. The Cephalaspis is the best known amongst these fish, and was the first discovered. Agassiz gave it this name on account of the peculiar form of the head, which he compared to a shield or buckler (κεφαλὴ, head; ἀσπὶς, shield); whilst at the same time he associated with the true Cephalaspis another fish which has since been shown to be quite distinct, and has been placed in another genus, Pteraspis. The original type of the genus was the Cephalaspis Lyellii, which is by far the commonest species; and at the time it was described, many specimens of the head were known from Herefordshire, and some beautifully preserved examples in which the body was attached; one of these last was from Scotland. In our plate (fig. 1) the head of the *C. Lyellii* is drawn; the various details have been taken from two or three specimens, since no single specimen can be obtained perfect enough to present all that is known of its form. At first sight one would be inclined to regard this queer shovel-like body as anything but the head of a fish; and, indeed, for some time it was quite excusably considered to be the head-plate of some crustacean allied to the Trilobites or King-crab. The resemblance it bears to the cephalic shield of the Limulus is very remarkable. It is a semicircular raised disc, the angles of which on either side are terminated by two long processes or horns which are very finely serrated; palæontologists call these the "lateral cornua." In the median line the disc is produced backwards, and rather upwards, into a sharp spine which is called the "posterior cornu." The orbits are placed close together, very nearly in the centre of the disc. There are other irregularities on the surface, which correspond probably to the disposition of the soft parts which were placed beneath this shell. No lower jaw, teeth, mouth, or any organ of the sort have yet been

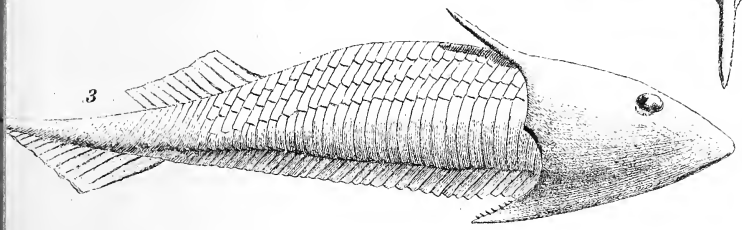
detected in any specimens, and palæontologists therefore conclude that the mouth was soft and probably used as a sucker, being placed on the under surface of the head, like that of the sturgeon. The remarkable position in which the eyes are placed, would, however, seem to render them useless as regards the detection of food if this were the case. The body which was attached to this head has almost as remarkable an appearance as the head itself; that is to say, it is remarkable when viewed by the side of those soft-bodied, degenerate fish which now inhabit our waters. A great variety of species of fossil fish possessed bony scales, and the Cephalaspis was one of these. The body was rather small compared to the size of the head, and tapering towards the tail (fig. 3). The scales were arranged in three sets on each side, those on the flank being long plates; they were all so arranged that the fish had the appearance of being enclosed in a suit of mail, "cuirassée," as the great icthyologist Agassiz termed it when describing the first known specimen. The markings on the surface of the scales are not well known, since the stone is so hard that they are destroyed in fracturing the rock. Of the fins of the Cephalaspis we only know two. These are the caudal fin or tail, and the dorsal. The caudal fin is supported by several rays, which spring from the lower side of the tapering, pointed termination of the body. It is of that kind known as heterocercal, such as the sharks and dog-fish possess now-a-days; whilst most recent fish have a homocercal tail, in which the fin rays instead of springing from the lower side of the vertebral column, arise from it equally above and below. All very young fish at first have a heterocercal tail, which afterwards in most recent forms becomes homocercal; and it is somewhat interesting to find this peculiarity of the early stage of a fish's life, characterizing the earliest fish which are known to us. The dorsal fin was placed near the tail, and was rather long. In two specimens which we have seen, there are traces of a membrane connecting the two lateral horns of the head-disc with the body. These may have represented pectoral fins, but better specimens will one day, it is to be hoped, show us more of them. The microscopical structure of the shield of Cephalaspis is interesting, since it affords one great reason for separating this fish from Pteraspis. The bone of which the head is composed was covered by a membrane or skin of some description which was very full of blood-vessels, since we can see the canals in which they ramified on the surface of the shield. In some specimens we find an appearance like a number of hexagonal plates, or minute starlike bodies (fig. 8) on the specimens of the Cephalaspid's head. These were at

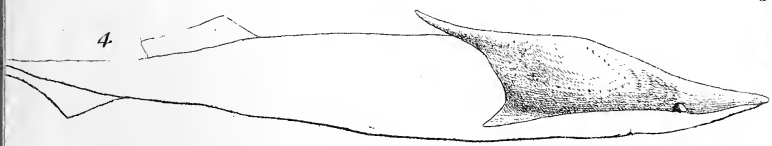
one time thought to be scales, but Professor Huxley has shown that their appearance is owing to the bloodvessels which ramify through the bony disc. By making a horizontal section of a portion of the head of the Cephalaspis, and placing it under a powerful microscope, we can detect the bone-cells or lacunæ; and this of course would have proved that these curious heads belonged to vertebrate animals even had we never found the bodies (fig. 7). What were the food and habits of the Cephalaspis it is hard to say. Some persons are inclined to think that the waters which deposited the sandstone in which they are found was a great fresh-water lake, and that these creatures and those we have yet to describe, went creeping about the bottom with their great flat heads and staring eyes, sucking in the minute worms and animalcules which swarmed there; for as yet no molluscous animals or any remains which would lead us to believe in the marine origin of these rocks have been met with in them. There are four or five species of Cephalaspis known; the commonest is the *Cephalaspis Lyelli*, which we have just described. In the passage beds and uppermost Silurian rocks there are the *Cephalaspis Murchisoni*, *C. ornatus*, and *C. Salweyi*, which differ but little from the commoner species. In Russia, M. Pander has found two species of Cephalaspis, which have a beautiful series of symmetrically arranged tubercles on the surface of the disc. Although these Cephalaspidian fishes appear very quaint in their form and proportions when compared with the commoner fish which now swim the seas and rivers of Britain, yet if we go to more distant regions, we find fish which present many of the remarkable characters of the Cephalaspidæ. Thus the bony pike, or *Lepidosteus*, of North America, has thick bony scales instead of those thin membranous flakes which cover our English pike, and the scales of another—the *Callicthys*—resemble still more those of Cephalaspis; whilst in the Ganges there are several fish the form of whose head is strangely like that of the ancient buckler-head.

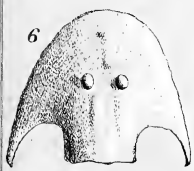
But we should now pass on to the next genus of Cephalaspidian fishes—the Auchenaspis. There is only one species of Auchenaspis known, the *A. Salteri*, whose head we have represented in fig. 6. It is very much like that of Cephalaspis in shape, but is not nearly so big, being scarcely larger than a shilling; whilst, as we should have mentioned before, the largest diameter of the cephalic disc of Cephalaspis is frequently as much as six or seven inches. The Auchenaspis has been separated from the Cephalaspis on account of the posterior enlargement of the disc into a sort of neck-plate and the absence of a spine. Many palæontologists are inclined to

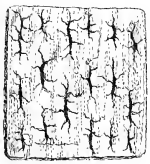


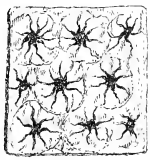


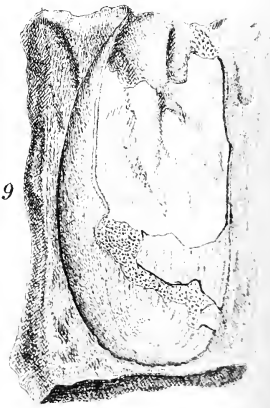


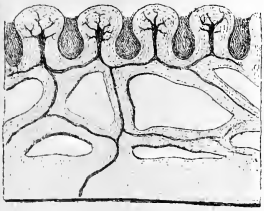


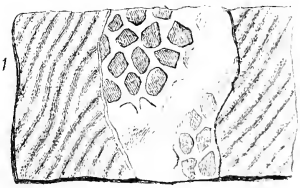


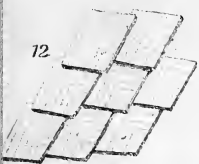


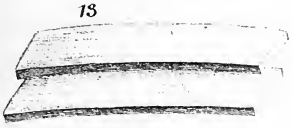












R. Lankester, del.

W. West, lith.

Fishes of the Old Red Sandstone.

BRITISH MUSEUM
NATURAL HISTORY

regard it as merely a species of Cephalaspis; but since so eminent an authority as Sir Philip de M. Grey Egerton was the founder of the genus, we cannot dispute the propriety of the separation. We know nothing of the body of this little fish, although we may be pretty certain that it was similar to that of Cephalaspis. Its remains are rather plentiful in the passage beds which connect the Old Red Sandstones with the Silurian rocks; from Ledbury in Herefordshire we have seen a specimen of rock with as many as a dozen heads upon it.

The last genus which we have to describe is the Pteraspis, and of the three it is, perhaps, the most interesting; for many mistakes have been committed in assigning the fossil remains of this fish to various classes of creatures, and it is only quite recently that we have had undeniable proof of their piscine nature. Many years since, Agassiz received fragmentary specimens of the cephalic shield of the Pteraspis, and he at once concluded that they belonged to a fish which he placed in his genus Cephalaspis. Since then Dr. Kner of Vienna obtained some imperfect specimens, and remarked that their elongated oval form was very similar to that of the cuttle-bone; and on making a perpendicular section through the shell or test he found a structure which he considered to be very similar to that shown by the "pen" from the interior of the *Sepia officinalis*, or common cuttle-fish. Dr. Kner therefore placed these remains in a new genus, Pteraspis (πτερόν, a wing—ἀσπὶς, a shield), and classed them among the mollusca. The matter, however, was not allowed to rest thus; the truth was still to be discovered. Professor Huxley made a careful examination of the microscopical structure of the cephalic discs of both Cephalaspis and Pteraspis, and having better specimens than Dr. Kner had at his command, came to the conclusion that Pteraspis was a fish, but generically distinct from Cephalaspis. In fig. 10 we have drawn a highly magnified view of a perpendicular section through the cephalic disc of Pteraspis, and in fig. 11 a less highly magnified view of the surface is given. The test consists of three layers of bony matter deposited in layers; the outermost one is striated, or delicately grooved, like the human skin on the palm of the hand. The middle layer is composed of polygonal cavities, and the internal layer, which is the thickest, is made up of a nacreous laminated substance. These layers may be seen in the figures. Canals ramify through these layers, and end in an arborescent form in the external layer. There are no lacunæ, or bone cells, as in Cephalaspis, and this affords an important distinction between the two fish. But the general contour of the cephalic disc of Pteraspis differs considerably from that of Cephalaspis, although the type of construction is the same

(fig. 2). The lateral horns are shorter, and are placed so as to expose a lateral angle on each side; the whole disc is more lengthened than in Cephalaspis, and is produced forwards into a snout or "rostrum;" at the sides of this the orbits are placed, instead of being situated in the centre of the disc. The striations on the surface are arranged in a very beautiful and symmetrical manner, running parallel with the edges of the shield. The posterior spine is inserted into the disc as a distinct piece.

Most of the specimens which are found are very imperfect, leaving their outer shell in the matrix from which they are extracted; the rostrum, too, and the lateral and posterior cornua are generally so concealed in the rock, as to render it impossible to work out the whole disc in a perfect condition. The specimens usually seen are in the condition represented in fig. 9, and hence Dr. Kner's difficulty in believing that the pteraspis could be a fish. If the body had come to light we should have had no difficulty about the matter; but it is only just lately that any signs of even the scales of Pteraspis have been seen. The writer went last summer to one of the quarries in Herefordshire in search of the remains of Cephalaspis and Pteraspis. Having obtained some few specimens, he visited the house of one of the workmen, there to increase his collection of remains. "Now, sir, what do ye think that may be?" said the quarryman, handing the specimen drawn in fig. 5. "My opinion is that it is a fir-cone." The specimen was examined, and found to be nothing more nor less than the long-looked-for scales of Pteraspis. There could be no doubt of it, for a portion of the remarkably characteristic shell of the cephalic disc, with its three layers, was adhering to the scales. An exchange was soon made with the quarryman for his stone, by means of the "current coin of the realm," and the disentombed scales of that ancient Pteraspis were comfortably packed in wool and paper. The markings on the scales are shown in fig. 12, where they are slightly magnified.* Of course no one now can doubt that Pteraspis was a fish, the only thing that we have to regret is that we know nothing of the form of its body. The cephalic disc was probably placed as is shown in the sketch fig. 4. Besides the Cephalaspis's and Pteraspis's heads and scales to be found in the cornstones of Herefordshire, there are numerous spines—such as is represented in fig. 14. These generally go by the name of "Onchus," but what "Onchus" is or was beyond a spine, no one knows. The probabilities are that these bodies belonged to the Pteraspis or perhaps Cephalaspis, and served to support

* See Journal of Geological Society. 1864.

some of the fins. But there is still much to be found out with regard to these curious fishes. There are several species of Pteraspis: one from the cornstones of Herefordshire, the *Pteraspis rostratus*, which is somewhat abundant, retains the name given by Agassiz. There are two or three other species met with in the Devonian strata, one being from Germany obtained in the neighbourhood of the Laache See. In the upper Silurian beds three species occur—*Pteraspis truncatus*, *Banksii*, and *Ludensis*—the latter being obtained in the lower Ludlow strata, and as yet the oldest fish that is known. In the vast thickness of rocks which underlie the upper Silurian strata, no one can tell what remarkable fish yet wait to be discovered. At present the members of the little group which we have just described, are the most ancient vertebrated denizens of the globe which geological science has brought to light. It can hardly be that no nearer approach to the lower forms of animal life existed in still earlier times, to connect these somewhat highly organised fish with the invertebrate class. Ere long we may have to describe still older and still more remarkable fish, which we trust will fill up some of those gaps, or represent some of those missing links which it is the geologist's duty patiently and perseveringly to seek.

OYSTERS AND OYSTER-CULTURE.

BY THE EDITOR.

TO eat oysters in July would be unpardonable; to write about them should be at all events excusable. If, therefore, there be any of our readers whose fastidiousness extends to that degree that even the mention of the "breedy creatures" in this season is objectionable to them, to such we offer our sincere apologies. Some may ask, why, knowing that, the propriety of treating folk to oysters in midsummer is at least questionable, have you not chosen some other subject? We shall explain. We are fully aware that these shellfish should not be eaten during *la période des mois sans* r, and that is the very reason why we have chosen them now as the subject of our remarks. The delicacy which characterizes our selection must be obvious to every one possessed of powers of reflection. We are influenced by two desires—one absolute, the other negative. We wish to preserve the infinitesimal proportion of humane feelings which even *gourmets* may be said to possess, and also to avoid depriving those who delight in eating oysters, of their appetite. For example, how destructive of the better feelings of our readers, to inform them that a "native" had a heart and nerves, and the faculty of sensation! Eat the succulent creature they must, but at the same time their more kindly sympathies would undergo a species of suffocation. Then suppose they be members of the Royal Humane Society. How terrible! Again, conceive of the disgust which must inevitably be created by the idea, that whilst devouring the delicious bivalve one is really swallowing a semi-living stomach with its contained undigested mass, a heart which has hardly ceased to throb, and a brain which perhaps at the very moment was unconsciously dreaming of its security! No, no, our readers' comfort is a matter of moment to us. While they read the following pages they can as it were examine the oyster from an abstract stand-point, and by the time the season again approaches, the gastronomic tendencies will be in the ascendant, and all that concerns this article will most probably be consigned to oblivion. The foregoing are, then, the reasons why we have chosen the present as a fitting opportunity to say a few words about the oyster.

Fig. 1.

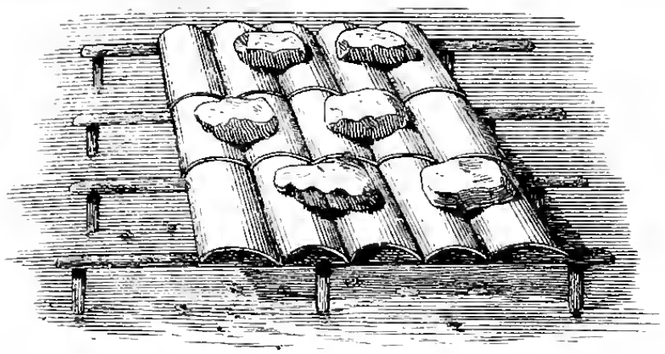


Fig. 2.

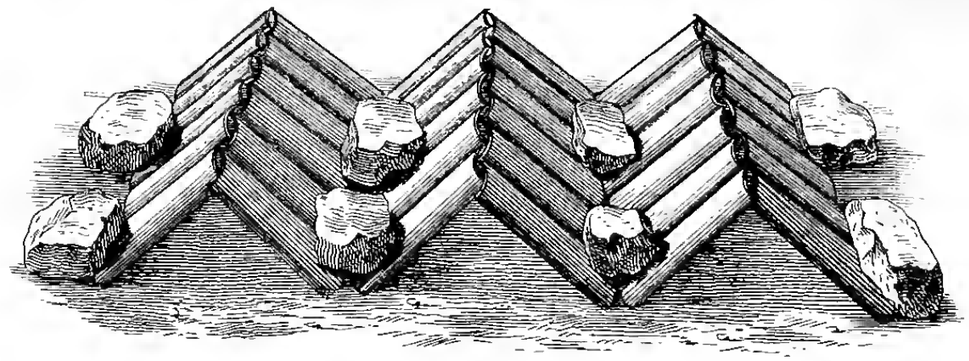


Fig. 3.

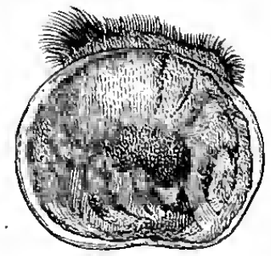


Fig. 5.

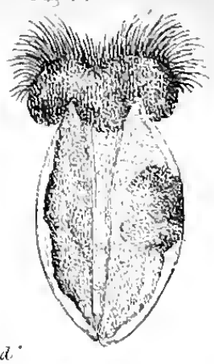


Fig. 6. *greatly enlarged*

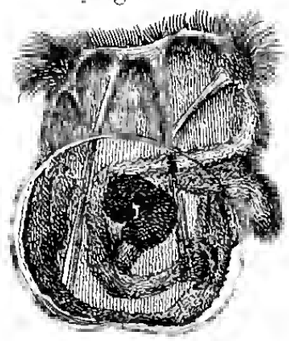


Fig. 4.

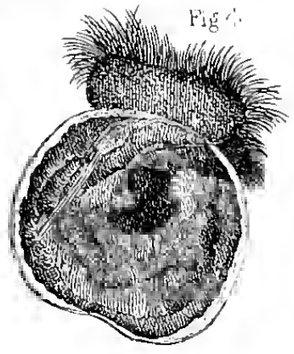


Fig. 7.

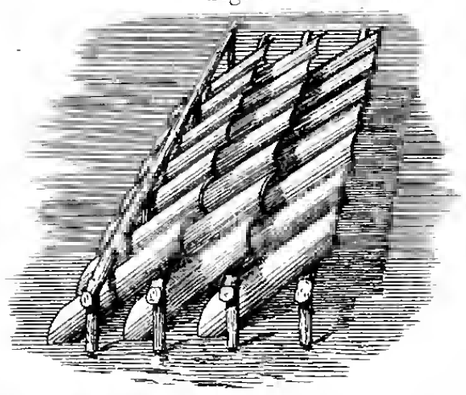


Fig. 8.

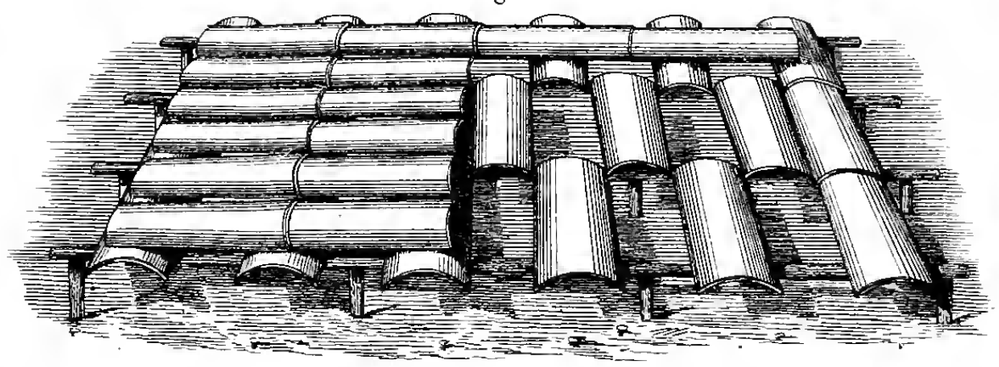


Fig. 9.

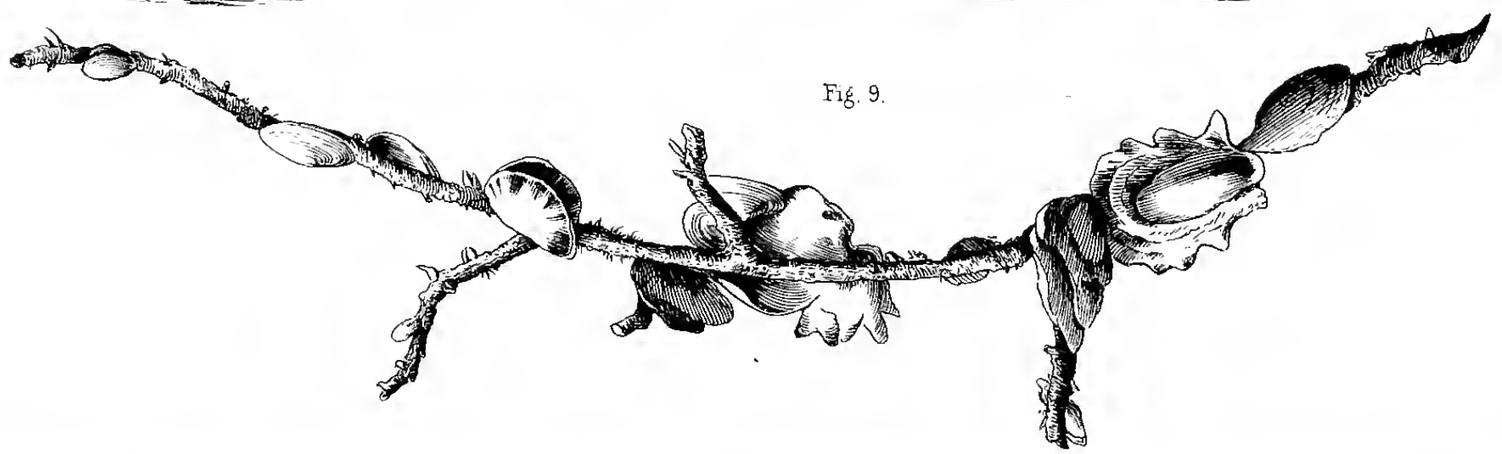


Fig. 10.

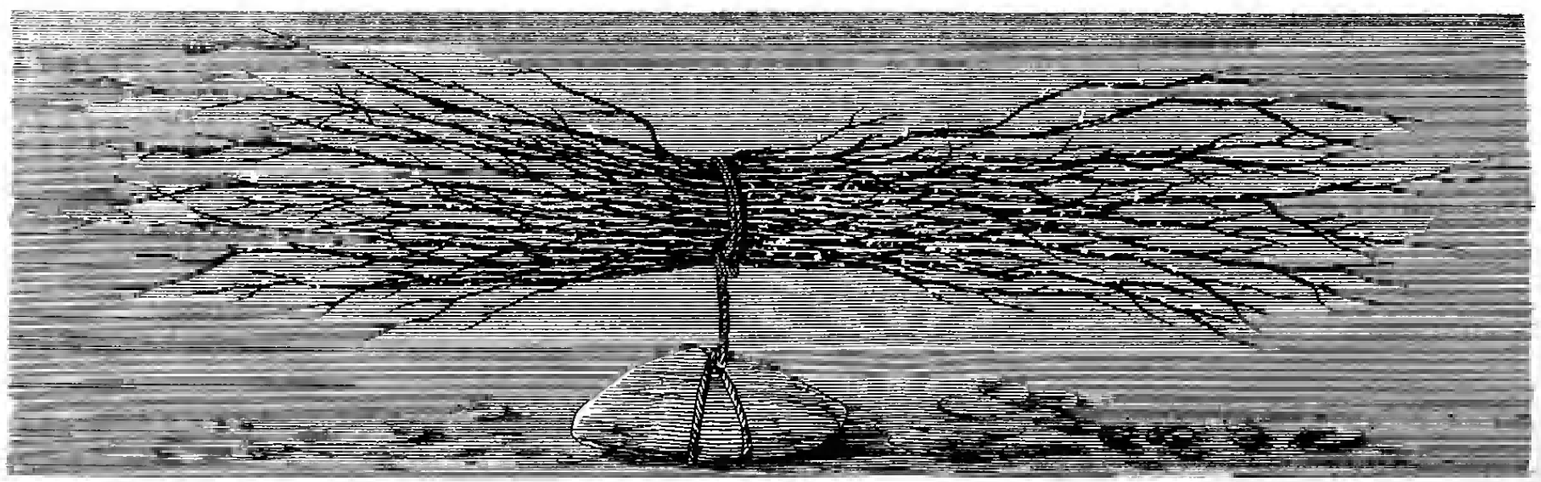
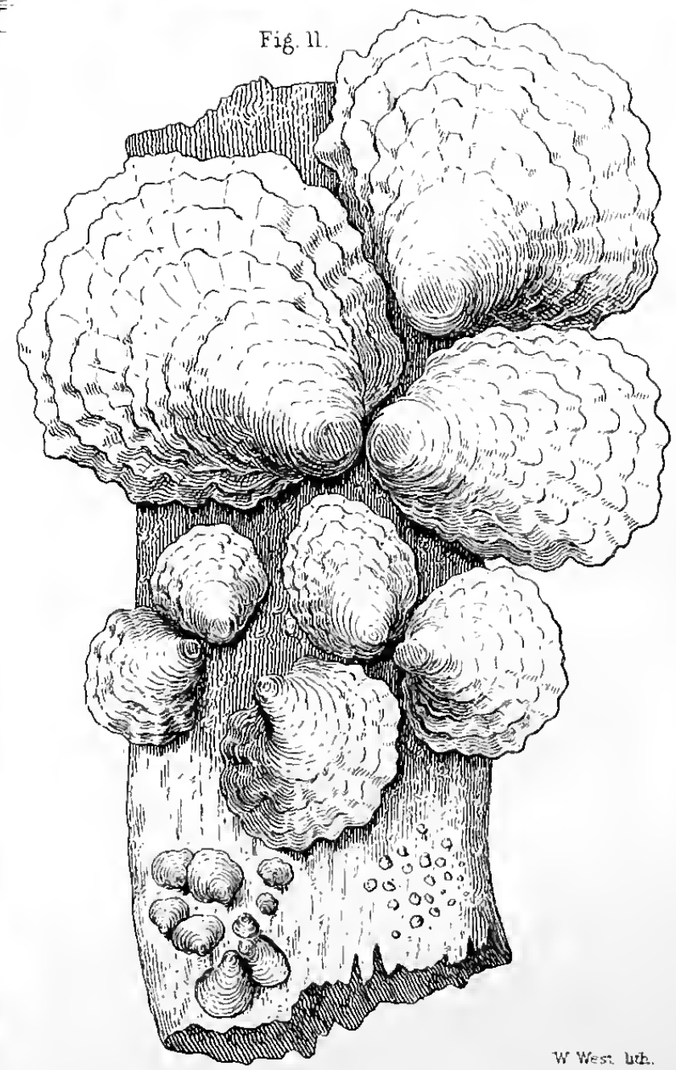


Fig. 11.



W West. lith.

Oyster Culture.

BRITISH MUSEUM
NATURAL HISTORY.

Oysters appear to have been known to the ancient as well as the modern populations of the globe, for we find that they were not only held in esteem by the Athenians, but were eaten extensively by the Romans, who in all probability knew quite as much about their cultivation as we do at the present day. To give the history of the oyster as it was bred, cooked, and eaten in the days of Horace, Cicero, Seneca, &c., would require a volume of monstrous size, and would be quite beyond the space at our disposal; so we shall dismiss the subject in observing that the wealthy Roman, Sergius Orata, was the originator of artificial oyster breeding.* He it was who formed the enormous beds of oysters at Baia, and who carried his culture of these shell-fish to such an extent both here and in Lake Lucrinus, that he was prosecuted for "trespass," by the celebrated orator Considius. It must also be stated, to the credit of the English "natives," that the Romans who first became acquainted with them in the time of Agricola, preferred them to their own, and gave to them the name of "Rutupians," from that of the locality — Richborough (Rutupium)—in which they were found.

In zoological parlance the oyster is termed *Ostræa edulis;* most probably our term oyster is a corruption of the generic title, which was also the Latin name.† The Greeks called it ὄστρεον, and used the shells as we use the balls of a ballot-box, the shell being termed ὄστρακον; the expression ostracise was thus originated. Being possessed of a double conch which opens and closes by means of muscles and a hinge, it is said to belong to the class of bivalves, and from having its gills arranged in folds it is designated a Lamellibranch. The oyster must have existed for many centuries before a trace of civilization appeared in Europe,—nay, before even man himself came upon the scene. From the writings of the late Edward Forbes, we learn that "the discoveries of geologists open scenes of regret to the enthusiastic oyster-eater, who can hardly gaze upon the abundantly entombed remains of the apparently well-fed and elegantly-shaped oysters of our Eocene formation, without chasing 'a pearly tear away,' whilst he calls to mind how all these delicate beings came into the world and vanished to so little purpose." Near Reading, in Berkshire, there exists a fossil bed of oysters, the specimens from which possess all the features of our best modern ones. This bed extends over more than six acres of ground and averages two feet in thickness; but, large as it is, it bears no comparison to those which volcanic action sometimes tilts up

* See the ninth book of Pliny's Natural History.

† McNicoll's Dictionary of Natural History Terms. 1863.

along the shores of the South American continent, beds which in some instances are nearly thirty yards deep, and cover an area of *seventy square miles*.* So much for the distribution of the oyster in time. As regards its present geographical range, we may say that it extends from Iceland to Naples and the Adriatic.† It is not found in Greenland, but exists abundantly on the North American coasts: McAndrew has found it in Vigo Bay and off Gibraltar; and in his valuable report‡ we find it stated that *O. edulis* is found from Britain to the Mediterranean, at depths varying from four to forty fathoms. The oyster does not belong to the eastern hemisphere, and judging from the huge quantities contained in the Danish kjökkenmöddings, § it must have had a wider European range during the "stone" period than it has at present. ||

It is hardly necessary in dealing with the anatomical characters of the oyster to say anything of its form; its weight, however, may be said to be no indication of the amount of flesh within its shell. Mr. Thompson, of Belfast, once found an oyster which, though some two pounds and a half in weight, did not contain two ounces of animal matter within its valves; and Mr. Buckland possesses specimens of North Sea oysters which consist of "an immense quantity of shell and but little flesh." It may be stated as a general rule that, beyond a certain limit, the larger the oyster the smaller in proportion is the quantity of flesh which it contains.

Anatomically, the oyster is not the highest member of his sub-kingdom (Mollusca or shell-fish), for though highly organized in other particulars, he is deprived of a head. The various parts which constitute his body are wrapped in a sort of membranous fold (the mantle), which not only encloses them within it, but forms the shell externally, by abstracting the mineral constituents from the surrounding water. The organs which our *ostræa* possesses are the following:— Stomach and digestive canal, liver, heart, and blood-vessels,

* Vide "The Oyster; when, how, and where to find, breed, cook, and eat it," p. 35.

† Jeffrey's "British Conchology," vol. ii., p. 40.

‡ Reports of the British Association for 1856, p. 114.

§ Lyell's "Antiquity of Man," p. 12.

|| In keeping with the subject of "kitchen middens" which we have just alluded to, we may mention the fact that in Corsica there exists a perfect island of oyster-shells, which are supposed to have been the refuse heaps formed by the Romans after salting the oyster for exportation. See the *Intellectual Observer*, No. VI., p. 483.

gills to breathe by, muscles to close his valves, reproductive glands and nerves. First, of his digestive system: there can hardly be said to be a gullet; the mouth which is placed at the bottom of the mantle cavity, and which is provided with a pair of fleshy lips, opens almost directly into a large stomach which is perforated by the canals, bringing bile from the liver. To the other end of the stomachal sac is attached the intestine; this is longer in the oyster than in most bivalves, and is very much twisted and coiled, in its passage to the anus, which lies upon the back of the muscle that closes the valve, and is placed upon a projection which points towards the smaller shell. The liver is a large and important gland, buried in the substance of the animal, and of a deep brown colour. It consists of numerous lobes or folds, which in their turn contain smaller cavities, within which the true hepatic cells may be seen.* The process of digestion is carried on as much in the intestine as in the stomach, and consists in the solution and absorption of the green vegetable matter (*Navicula*) upon which the animal feeds. The heart—unlike that of most of the oyster's kindred—is not perforated by the intestine; so that, as an amusing writer observes, "the way to his heart is not through his stomach." It is situate at the hinder extremity of the creature's back, and is composed of three cavities, two of which receive the blood which has been purified in the gills, and the third of which pumps the vital fluid through the arteries. The circulation, however, is not a perfect one, for there are no vessels between the arteries and the veins, and the blood which escapes from the former traverses the different spaces (*lacunæ*) of the body before it enters the latter. The nutritious fluid itself is colourless, but contains several of those "coarse granules" which were first pointed out by Mr. Wharton Jones.† These spaces form a beautiful network, which, however, must not be confounded with another series of cavities, supposed by some to be connected with what is called an "aquiferous system."‡ The gills or branchiæ have been observed by every one: they are those delicate fringes which are seen within the beard when the oyster is opened. These, which are four in number, are composed of folds of the membranous mantle containing blood vessels abundantly, and covered on their outer surface with thousands of delicate vibratile microscopic filaments called *cilia*. According to Williams's researches, § these gill-plates are chiefly

* See Meckel's memoir in Müller's "Archives für Anatomie." 1846, p. 9.

† "Philosophical Transactions," 1846.

‡ Consult Milne Edwards's Memoir in *Comptes Rendus*, XX., p. 271.

§ "Reports of British Association" for 1851, p. 82

composed of blood-vessels bent upon themselves, and arranged in parallel series; moreover, the cilia are so disposed as to create currents which set in the direction in which the blood itself flows. The gills being constantly exposed to the freshly oxygenated water, allow the blood to be purified by exposure, and then returned to the heart, to be propelled to the various organs which require it. The oyster has one good muscle, and only one; it is that which closes the two valves, and which is so ruthlessly severed by the knife in opening the shell. It is a solid mass of fibres, firmly attached to the inner surface of both valves, and situated at about the centre of each, which during contraction it approximates to its fellow. The nervous system is by no means so unsymmetrical as some anatomists would lead us to suppose. There are three pairs of nervous centres which are connected by true nerves, and the latter send branches over the body. The first pair is placed near the mouth, one lying on each side of this organ, and being united to its fellow by nervous chords of extreme tenuity; the second is situate behind, close to the gills; and the third, which is feebly developed in our bivalve, is placed near the labial mass.* That portion of the nervous apparatus which is located near the animal's mouth, may fairly be regarded as constituting a species of brain.

A great deal of controversy has taken place regarding the connection of the two reproductive organs in this animal.† Some naturalists contend that the oyster is hermaphrodite, others, that in it the sexes are distinct.‡ We are inclined to adopt the latter opinion, of which we shall have more to say further on. Can the oyster see? This question has been answered in the affirmative by Will,§ who states that there are as many as thirty distinct eyes projecting from the border of the mantle; but Siebold denies that such is the case, and regards the so-called eyes as simple excrescences, devoid of optical powers. So the question rests. There can, however, be little doubt that these molluscs are sensitive to light.

Having said so much about anatomical characters, we may now turn to other matters. The average age of the oyster,

* Brandt's "Medical Zoology," vol. ii., and Garner, in the "Linnæan Transactions" for 1837, p. 485.

† Coste, "Voyage d'exploration sur le Littoral de la France." 1861, p. 104. Kemmerer, "Oyster Cultivation in the Island of Re," translated by Mr. T. Ashworth, 1864. Lowe, "Journal of Society of Arts," May 20, 1864.

‡ Quatrefages, *Comptes Rendus*, t. 28, p. 292. Von Siebold, "Vergleichenden Anatomie," article "Acephala."

§ In "Frorieps Neue Notizen" für 1844, No. 622.

what is it? This question has not been satisfactorily answered; but there can be little doubt that the animal attains to a great age in some cases. From an examination of the shells of certain fossil oysters, it would seem that their years must have numbered at least one hundred; but evidently these were exceptional instances: Billingsgate had no existence in those days. There is not much to be said about the habits of the oyster. It has no power of locomotion, except when in the embryo condition: consequently, Lister's tales about the change of position with that of the tide, may be considered purely fabulous. Vegetable food is the kind it loves, and when this is abundant, the oyster fattens. It affects a warm temperature, and does not reach perfection in cold climates. Hence it is, as Mr. Buckland states,* that the oysters on the west of France, which are warmed by the Gulf Stream, have the advantage over our "natives." A sandy or muddy bottom, and comparatively shallow water, are most congenial to the adult oyster's tastes. It is as yet a question, whether it will live in fresh water as well as in salt; but, from the evidence of Dr. Kemmerer, it would appear that fresh water only influences it as to flavour, and has no effect upon its growth, fattening, or virility.

Next we have to consider the enemies of the oyster. First come the mussels, which accumulate mud, and thus suffocate the young; then the star-fish, which grasps the oyster with its rays, and with its everted stomach eats the entire animal; a species of sponge which makes its way into the interior of the shell, and does considerable damage; the oyster-catcher, which kills its thousands; the sea-urchin, which devours the embryos; and last, though not least, the cold, which arrests development, if it does not kill the animal at once.

With so many different beings and circumstances hostile to its multiplication, it is surprising that such numbers of the oyster should still exist. The great fertility and prolificness of the mollusc explain why it is not already extinct. Whether oysters be, or be not, hermaphrodite, we shall not now discuss. The subject is one which, from its purely technical nature, and from the extent of space its discussion would occupy, cannot be dealt with here. It may (taking either view) be stated, that each egg-producing individual gives birth to from *one to two millions of young* at each period of spawning. The eggs are developed and extruded during the months of May, June, July, and August; and this is why the oyster is unfit to be eaten during the summer. The ova are not, as certain writers

* Letter to the *Times*, May, 1864.

suppose, ejected in squirt-fashion, from the parent: their development and growth proceed gradually, and as they—series by series—leave the ovary, they pass to the outer gill-folds, which play the part of a uterus. Here they are retained in the various compartments, and, by the action of the cilia, the zoosperms are introduced, and thus the ova become fertilized, and are afterwards slowly extruded.* Let us trace the further development of the embryo. Just as the yolk is about to undergo segmentation, we observe two portions of it set apart: these do not suffer division, but are soon changed into as many three-sided valves, whilst the remainder of the mass is converted into a small roundish body, recovered with vibratile cilia, by means of which it is caused to move slowly round and round. As soon as it leaves the parent and can be examined, it is then seen that the cilia are not indiscriminately disposed, but are arranged upon a sort of pad or fleshy cushion, which projects from between the valves. This peculiar apparatus, which was discovered about ten years ago by M. Davaine,† is provided with several muscles, by which it can be extended or retracted, at the will of the animal. Its construction and position are well shown in the accompanying delineations (Pl. XVIII., figs. 3, 4, 5, and 6). What is the use of this strange mechanism? It is to admit of the distribution of the species which, were it absent, would be for ever confined to one locality, and the result of this would be starvation of the colony. The young oyster swims away when it leaves the parent; but it soon tires of its adventures, and after a couple of days it settles down into respectable oysterhood, and commences life on its own account. Its "swimming belt" now becomes atrophied, and disappears, and our protégé attaches itself to some solid body, where it remains for the rest of its days. When it is fifteen days old, it is about the size of a small pin's head, and has the form represented in the engraving (Pl. XVIII., fig. 11), which also shows its gradual increase of size, till it is twelve months of age. Ere concluding our remarks on this branch of the subject, we may mention that, in the opinion of Mr. Eaton, who has carefully studied the development of the oyster, the production of ova—which in some cases extends

* Vide Siebold, loc. cit., and Kemmerer, loc. cit., p. 17.

† "Recherches sur la Réproduction des Huîtres," *Comptes Rendus*, 1855. M. Coste, in his fine memoir, gives a brief description of the process described by M. Davaine; but we fancy Mr. Ashworth has mistaken the author's meaning in the following passage, where, speaking of the ciliated pad, he writes,—"*à l'aide desquels l'animal peut, à volonté, le faire sortir hors des valves ou l'y faire rentrer.*"

to 3,000,000—is favoured by heat, and retarded by cold, and it is very probable that the oysters in certain beds never spawn, because of the great depth of the water, and consequent diminution of temperature.*

All sea-side readers, but very few inland ones, are familiar with the way in which oysters are obtained, and the sources from which they are derived; it behoves us, therefore, to say a word or two about oyster-beds and dredges. The former are vast accumulations of these molluscs, generally found in the open sea or on the coast-line, and more rarely in estuaries. They exist at depths varying from six to thirty fathoms, and are usually discovered lying on sandy or muddy bottoms. The dredge is a kind of net made of coarse rope, and attached at its mouth to an iron framework of a rectangular shape, and about four times as long as it is wide. The upper and lower edges of this framework present tolerably sharp edges, and from its sides proceed two iron bars which are united in front by a ring of metal. When this instrument is about to be employed, a rope is fastened to the ring, and the apparatus is thrown from a boat which floats over the beds. The boat is then urged forward either by wind or oars, and the dredge scrapes the sea-bottom till it has filled its net with oysters, when it is drawn up and emptied of its contents. This is the way in which our oysters are obtained at present. Very extensive beds exist all round our coasts, but the most important are those of Kent and Essex, and the Milton, Queenborough, Rochester, and Faversham beds are too well known to need any description from us. Suffice it to say that such is the importance of this branch of commerce, that 700,000,000 ! of oysters are annually consumed in London alone, and quite as many if not more in the provinces. Now, supposing we value them at sixpence a dozen, which is certainly below the ordinary selling price, we shall then have an annual expenditure in England of about *three millions* sterling in oysters alone ! Could any fact more powerfully attest the value of this branch of commerce ? We fancy not. Let us then examine whether we are doing anything to increase and improve this important portion of our industrial resources, and what shall we find ? Why, that the demand for the commodity increases and the supply diminishes, and that this diminution is not merely relative—it is definite. When Mr. Lowe, one of the secretaries of the Acclimatisation Society, asked concerning the past and present produce of certain French oyster-beds, he was informed "that the number of

* Abstract of Report on Oyster-beds in "Reports of British Association" for 1856, p. 368.

oysters dredged from the deep-sea beds in the neighbourhood for use at Cancale, during the current season, had mounted up to little more than three million seven hundred thousand; whereas twelve years ago, at the same period of the season, the total would be *sixty millions!*" * The same authority states that Captain de Saumarez, of her Majesty's steamer *Dasher*, told him "that, a few years ago, when surveying between Jersey, Alderney, and the coast of France, he came upon a large bed of natural oysters lying in the bottom of the Channel, more than three miles in length, and of considerable breadth. The news soon spread, and in a very short time (such was the rapacity of the oyster dredgers) not an oyster was left to tell the tale." † Upon a question of this kind it is necessary to have evidence not only from ordinary observers, but from those whose position enables their observations to be accurate. Hence, the following statement from so high an authority as Mr. Ffennel, the Government inspector of fisheries, is highly valuable. Mr. Ffennel asserts that "there was one place in Ireland, which some years ago gave employment to some two thousand people in the culture and collection of oysters. The beds there were worked to such an extent, that the mere freight in one week often amounted to £1,000; but so recklessly were the beds worked, that their entire produce at the present time did not amount to £300 per annum."

In the presence of such facts, it cannot be denied that our oyster trade is declining. It is equally true that if something be not done, all our resources will be exhausted, and the oyster in a few years must be regarded as a thing of the past. Shall such things be? Shall no steps be taken to ameliorate the condition of our oyster beds? These are the questions which are now, almost for the first time, put before the English public. It must be confessed that in many particulars we are behind other nations, and certainly in nothing more than in pisciculture. Look, for instance, at what our Gallic neighbours have been doing with hand and brain to increase the supply of oysters, while we with mouth and stomach have been exerting ourselves to diminish it! We are waking up to a sense of our position now, but the French mooted the question as early as 1845. M. Carbonel ‡ was the vigilant sentry who first detected the approach of the enemy. In October, 1845, when reading his memoir before the Academy, he said: "It is unquestionable that the oyster will disappear

* "Journal of the Society of Arts," vol. XII., No. 600. † Ibid.

‡ "Sur l'Huitre des Côtes de France," reprinted from the "Magazin de Zoologie." Paris, 1845.

from the French coasts, unless means be adopted to preserve and reproduce this important shell-fish." Again, in 1849, Professor De Quatrefages * addressed the Academy in almost similar terms, upon the very same subject. Their object was soon attained. The Government appointed M. Coste to investigate the matter, and report the results of his inquiries.

M. Coste's "report" was sent in in 1855, and a second edition of it was published in 1861; from this we learn what the French are doing to increase the oyster supply, and with what success their efforts have been attended. The great aim was to obtain the young oysters in as large quantities as possible in order to preserve them from the various destructive agencies we have already mentioned. How was this to be effected? It was known that the young attach themselves to solid bodies, after enjoying their freedom of isolation for a day or so. It seemed probable therefore, that, if different materials were artificially submerged in the vicinity of the oyster beds, the embryos would become adherent to them. This anticipation proved correct. After several experiments had been made, two methods were adopted for collecting the young: one was employed when the oyster beds were far out at sea, the other when they were adjacent to the shore. In the first process, fascines were used; in the second, tiles. The fascines consisted of bundles of branches of trees with the bark on, fastened together with galvanised wire, and sunk in those localities where the oyster-beds presented themselves (see Plate XVIII., fig. 10). These fascines were allowed to remain submerged during the spawning season, and were then removed, when it was found that each branch was covered with young oysters as exhibited in the sketch (Plate XVIII., fig. 9). When the oyster-beds existed close to the coasts, tiles were then employed. The tiles used were those with which they cover the ridges of house-roofs, and were either completely covered with a sort of Roman cement, then called fixed cement, or were coated with the material in such a manner, that the latter could be removed at pleasure, in which case the term moveable cement was applied to it. When the tiles thus prepared were removed from the sea where they had lain during the spawning season, they, like the fascines, were found to have been coated with young oysters. In both the cases of tiles and fascines, it was necessary to remove the shell-fish from their temporary abode. This was done in the latter instance by breaking the branches, and in the second by two methods—by removing them with a gouge from the fixed cement, and by breaking up the

* *Comptes Rendus* for February, 1849.

stratum of material which had lain without much adhesion on the tile with moveable cement.*

Both of the above methods are still adopted, but that in which tiles are the medium is the most general. The tiles are usually mounted on posts driven into the sea-bottom, the object of this arrangement being to prevent the accumulation of mud and silt. The simplest form of tile collector is that which consists of a number of tiles placed upon horizontal bars and retained *in situ* by means of heavy stones. (Pl. XVIII., fig. 1.) Figure 8 shows a variety of the first form, resulting from a combination of two. Fig. 7 illustrates another variety where the tiles are arranged obliquely, and in an overlapping manner, whilst in fig. 2 we have represented a collector in which the tiles are placed against each other like the rafters of a house. The cement in each case lines the concavity of the tile, and the numerous currents drag the embryo oysters along, and allow them to become attached to it.

The end to be gained by all these different apparatus is the same—the collection of the young. This, however, is not the only thing to be effected: after the oyster has been detached from its temporary resting-place, it must be fed and fattened. How are these processes carried out? Along the foreshores there are constructed reservoirs of a certain depth, and with a firm bottom. These are provided with sluice-gates, and are so arranged that when the tide retires, the water is retained. In these reservoirs the young detached oysters are carefully laid, convex side downwards, and there they are allowed to remain, feeding upon the abundant vegetable matter, and luxuriating in the increased temperature, till they have grown large enough for the market. These processes are fundamentally what the French have carried out, though of course, in many instances, with considerable modifications, whose description would be out of place here. The results have been incontestably successful. The increased supply of oysters in the once exhausted beds of Rochelle, Marennes, Rochefort, and the Bay of St. Brieuc, is a fact sufficiently corroborative of the truth of this statement. But the most convincing evidence of all is that afforded by the Island of Ré. *Five years since, the shores of this island were barren and uncultivated; now, they give employment to* 3,000 *men, and the crop which was produced in* 1861 *was valued at* £320,000 *sterling*. Nothing could be more satisfactory than this achieve-

* The moveable differs from the fixed cement in being *attached* to the edges only of the tiles, though spread over their surface. Both forms are the same chemically.

ment which practical science has arrived at. Well may the two zealous labourers congratulate themselves upon the vast benefits they have conferred upon mankind. MM. Coste and Kemmerer deserve the substantial gratitude of their fellow-countrymen, and merit the high esteem of all who are interested in practical pisciculture. The French Government has done all that could be expected of it. Why, then, is the Government of this country so remiss? A great national benefit is offered, and are no steps to be taken in order to accept it? We may conclude in the language of one who has, even in this country, done much to forward the good work:—

"To cultivate the sea; to till and sow the shore like a cornfield; to cover the salt sand with rich and nutritious crops: this will be an achievement indeed! And that it is not an impossible one, the example of what has been done upon the French coast gives us a sure and certain proof. Let us set about it.

THE PNEUMATIC DESPATCH.

BY S. J. MACKIE, F.G.S.

UNDERGROUND London in the course of a few years will be quite as wonderful as London above ground. The great arteries of the main-drainage, now the most wonderful of our present subterranean labours, will perhaps twenty years hence have to cede their supremacy and give place to something even more marvellous. Passing over the intricate net-works of gas and water pipes and electric wires, we have already the first instalment of underground passenger locomotion in the Metropolitan Railway, and the first instalment of a more extraordinary means of transit for goods and merchandise, in the short length of pneumatic pipe between the Euston Square terminus of the North-Western line and the North-Western district post-office. What the science of hydrostatics is for water, pneumatics is for air, and the Pneumatic Despatch Company is a commercial company with large capital, formed for the simple purpose of blowing or sucking gigantic pellets of merchandise through long iron tubes. We say simple, for everything is simple now-a-days to the increased intelligence of the nation; and there is not an educated person who would not at the first description understand the main nature of the pneumatic despatch. The pneumatic tube has been compared by a popular writer to a boy's pea-shooter. The comparison is scarcely right. The pneumatic apparatus is more nearly comparable to the wheel-bellows our housemaids use in blowing up their fires. Still, the common pea-blower, or the longer South American Indian's blow-pipe, affords a good expression of the nature of the operation. The pea is put into the blower, or the dart into the blow-pipe, and a puff of the breath sends them through and projects them sharply from the other end. But it would be rather awkward to have the pellet-carriage ejected violently from the orifice of the pneumatic tube, like a cylindrical cannon-shot from a cannon's mouth. The carriages must come out gently, or damage would be done. It is easy to explain the manner in which the pneumatic despatch is practically worked. In the common domestic wheel-bellows, by the turning of a handle at the side of the bellows, a fan-

Fig: 1.

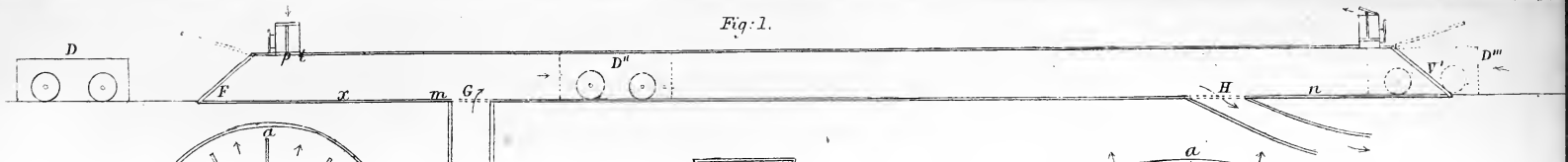


Fig: 2.

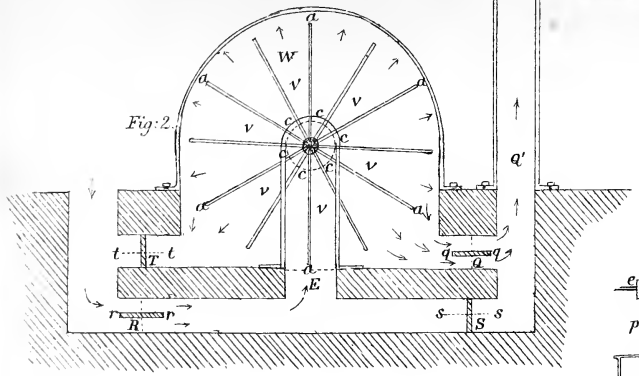


Fig: 4.

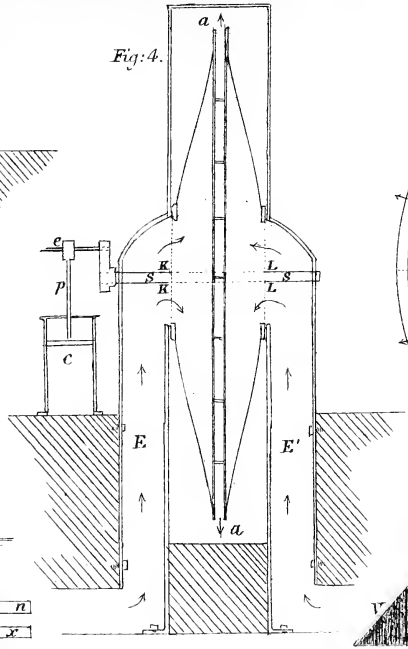


Fig: 3.

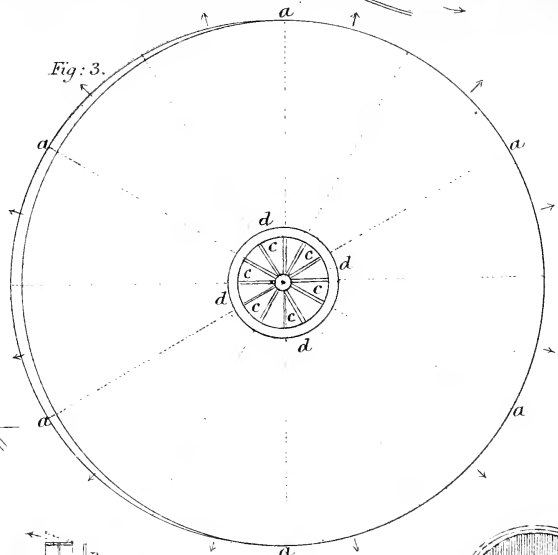


Fig: 5.

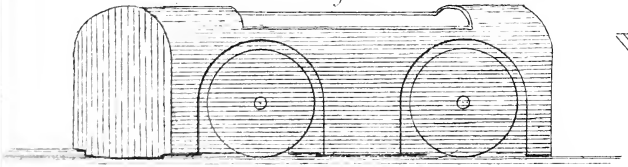


Fig: 8.

Fig: 7.

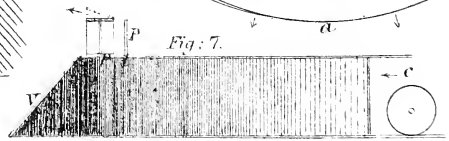
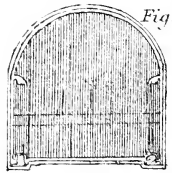


Fig: 6.



S. J. Mackie del.

The Pneumatic Despatch.

W. West, imp.

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wheel inside is made to rotate rapidly, and in its revolutions throws off by centrifugal force a continuous stream of air which issues from the nozzle. If a pea or a pellet were inserted in this nozzle it would be blown out, just as the pea is ejected from the pea-blower, or the dart from the blow-pipe. If the nozzle were extended for a mile, the same ejectment of any pellet within it would equally take place. Suppose it so extended and you have the rudiment of the Pneumatic Despatch. We shall make this clearer by describing briefly the apparatus which for two years has been in work at Euston Square. At the side of the railway station we enter a very unattractive engine-house. Within, on one side, is the end of an iron tube two feet six inches in diameter, closed by a flat iron valve. Beyond this is a short line of rails—some fifteen or twenty feet in length—upon which are some low iron carriages, like round mummy-cases with the middle part of their lids cut out, and running on four wheels closely indented into their sides. The bottoms of these carriages are flat, almost on a level with the lower periphery of the wheels, and close to touching the ground; the section of the carriages being indeed coincident in form with, and only about three quarters of an inch less in dimensions than the section of the tube itself. A padding of leather or india-rubber round each carriage nearly fills up the interval between it and the internal sides of the tube. On the opposite side of the house is the steam-engine, and in the centre is a great iron box or semicircular case, within which a large fan-wheel twenty-two feet in diameter rapidly revolves, like the fan-wheel of the fire-bellows. On either side of this case there is a tube opening into the interspaces of the fans round the axle of the fan-wheel. As the wheel revolves, the particles of air in these interspaces between the fans have the wheel's motion communicated to them, and then like water drops from a twirled mop have a stronger and stronger tendency, in proportion to their velocity, to fly off. As they stream away at the periphery of the rapidly whirling wheel, the air is sucked in as fast at its centre, from the air-feeding pipes at the side, to supply the vacuum created by their loss. Thus a violent stream of air is thrown off from the outer margin of the wheel, while a suction is established in the feed-pipes. We have thus a supply of wind at increased atmospheric pressure to blow, or propel from behind, the carriages through the pneumatic tube from its near end, and oppositely an exhaust through the feed-pipes to suck them through from the far end, as one would suck up water through a straw. It is a very small engine that does duty. And there is a curious fact connected with the work it does. It can do what steam-engines very seldom can—take its work easily. If we close

the valves of the feed-pipes no air can fly off at the periphery of the fan-wheel, because no air can get in to fill up the vacuum which would arise, and the natural pressure of the atmosphere has thus the power to keep the air within the interspaces of the fans. Consequently, if with closed feed-valves the fan-wheel be set in motion, no matter how rapidly it may be twirled, the enthralled particles of air will acquire exactly the same amount of motion as the fan-wheel itself, and both will revolve together as if the whole were one solid circular plate of rigid iron. When the rotation of the fan-wheel is made to take place within the inclosing case of the fan-wheel thus the result is identical with working in a vacuum. A very little power of the steam-engine will start the wheel and put it in slow action. As the wheel acquires motion the steam is released of resistance in its work, and the engine will acquire greater and greater speed, until the wheel be driven round with such velocity as to equal the rate of generation of steam—the only practical limit to this accumulation of force. The utmost speed of rotation is thus gradually acquired, power is accumulated in the wheel—just as it is in the child's humming-top—and if the feed-pipes be now opened the air will instantly rush off from the periphery of the fan-wheel, at the rate of forty or more miles an hour. Indeed, so great is the accumulated power in the wheel that its rotation alone, unassisted by the steam-engine, would be sufficient to blow or suck the usual train of carriages through the whole length of the despatch tube—something more than a quarter of a mile.

There is great economy in thus accumulating power, and it is consequently adopted in practice. The engine is started with a scanty supply of steam shortly before a train is sent, and the wheel put in motion and driven in this practical vacuum until extreme rapidity of whirl is acquired, when the train is despatched; but, as the surest means of avoiding dilemmas, the engine is continued to be worked at full speed during the transit. The carriages do not, however, shoot out of the despatch-tube like darts from a blow-pipe, or peas from the blower. They do not crash up against the end of the station, or knock over porters waiting to receive them. No such thing. A little before their arrival, the sound of their rumbling alters, the tube draws in a long breath, or blows a deep sigh, there is a click and a clatter of rods, the flat-valve at the orifice of the despatch opens of its own accord, and the pellet-carriage comes forth from the dark interior of its underground passage, runs itself clear a few feet on the rails, and stops without either break or touching. A toddling baby might pull it up as it comes forth to the day. How this is done is very simple—very simple, indeed; but marvellously

ingenious for all that. We have run gossiping on so far; we must now have recourse to our diagrams and drawings. And it will be well to say, none of these—saving the carriage—are portraits, or drawn to scale. They are sketch-diagrams, designed expressly to convey, in the most intelligible manner, correct explanations of principles. Fig. 1 is the despatch-tube—short in our drawing, but almost as long as you please, practically. The usual rate of propulsion through it for lengths under five miles would be some twenty-five or thirty miles an hour; forty miles have been got, perhaps very much more might be; but such power has not as yet been ordinarily applied. In longer distances the speed would necessarily be diminished, and indeed will diminish proportionately with length, until ultimately it would practically all but cease, unless the exhaustion of the tube were permanently and most powerfully maintained. Both ends of the despatch-tube in our diagram will be seen to be closed by valves v v'. This may rather astonish our readers, who may naturally ask how air is to be blown through or drawn out of an hermetically closed pipe. Well, it is only seemingly closed. There is a grating at G, and another grating at H. "But why shut up the pipe at both ends with valves, and open it again with gratings?" The "why" will presently be clearly enough perceived. Fig. 2 shows the fan-wheel (fig. 3) inclosed in its case. Fig. 4 is the same in section. When the fan-wheel (w) is whirled round, the air in the interspaces (*a c a*) between the fans (*a a*) will fly outwards from the periphery at whatever rate of motion that air has acquired, the instant an indraught from the exhaustion-tunnel E is let in between the fans at the centre of the fan-wheel (*c c c*), and an ex-current is permitted through the air-vent (Q Q'). Now let us set the fan-wheel at work. We have closed the valves T, S, Q, as also the valve of the air-chamber R, and the wheel is accumulating power *in vacuo*. We open the near terminal valve of the despatch-tube V, and run in the carriage D. We permit an out-draught from the fan-wheel case through the open air-chamber X, by turning the valve T (to *t t*). We allow an in-draught into the fan-wheel through the exhaust-pipe E, by turning the valve S (to *s s*). Instantly the exhaustion of the despatch-tube begins. The atmosphere is sucked in at its open end F, and at the distant grating H, and with it the carriage D is drawn along towards G, until, as it passes the grating G, it moves a trigger, which closes the valves V, T, and S, and opens the valves R (to *r r*) and Q (to *q q*). An in-draught of air now sets in through the feed-pipe E from the open air-chamber X, and acquiring rapid motion in the interspaces of the fan-wheel, is thrown off in a perfect gale

through the out-draught pipe Q Q′, and the grating G *behind* the carriage D″, which is thus blown rapidly on, driving out the air in the despatch-tube before it through the distant grating H. We shall now see the necessity for closing the tube at both ends. As soon as the carriage (D″) has passed the distant grating at H, the wind behind it ceases to propel it, for it at once escapes by the grating H. So, as the carriage has no means of maintaining its motion beyond the impetus it has received, its speed will slacken. But this is not all. There still remains in front of it, in the closed extremity of the tube (H V′) a cushion or buffer of air. This the close-fitting carriage compresses more and more, meeting with more and more resistance the more the cushion of air is compressed, until when its motion is nearly arrested, it passes over the trigger *n*, when the far-terminal valve V′ opens, and the carriage trundles quietly out and brings up on the short railway outside. Directly the train has passed the grating at H, the engineer shuts off steam from the stationary engine (fig. 2). How he knows it has arrived there is very simple too. With the despatch-tube is connected a pressure-gauge in the engine-room, and while the train is in transit, the atmospheric pressure is increased, and the gauge shows four or five ounces to the square foot—that is all. It is the *rate of exhaustion* of the despatch-tube, or the *rate of the propulsion of air into it*, that gives the velocity to the trains, not the pressure per square foot. The pressure per square foot gives *momentum* to the inert *weight* of the train, not speed of transit. The moment, then, the carriage has passed the grating H, the atmospheric pressure in the despatch-tube is released by the free vent given to the air, and the mercury or water in the pressure-gauge falls to zero. The engineer instantly knows that his duties are over.

Having now blown our carriage through, we want to get it back, or, otherwise, the other station wants to send a train. They have no engine and fan-wheel there, so we must *suck* it through for them. They telegraph to us that they have a train to send, and our engineer turns on steam. The fan-wheel revolves, we close the out-draught valve at Q, and the in-draught valve at R, at the same time opening the valves S and T. The exhaustion of the despatch-tube now commences, and the free atmosphere rushes in through the open end of the tube at V′, and through the grating H, and pressing on the superficial area of the end of the pellet-carriage D‴, forces it along through the tube as fast as the exhaustion proceeds, until the carriage has run over the grating G, when the exhaustion of course ceases, and the engine, if kept at work, merely sucks air through the then

perfectly open despatch-tube. This waste of steam-power is prevented by a trigger at *m*, which shuts off the steam and closes the open valves. Our carriage has now before it, at this end of the despatch-tube, a similar cushion of air to that which resisted its progress at the other end. As the effect of the exhaust upon it ceased at the open grating G, it has only its own momentum against the increasing resistance of the more and more compressed "buffer" of air in the extremity of the tube (G V), and as its speed becomes nearly entirely slackened, it passes the trigger *x*, the valve V opens, and it quietly finishes its journey on the open rails.

It will certainly occur to those who are acquainted with the resistive properties of air, that the effects of these terminal cushions of air will be directly proportional to the *weight* of the train received by them; and that while a cushion of one extent would bring up a single carriage, it would not arrest a light train, and be still less efficacious against a heavy one. This, too, is very simply provided for. Everything about the Pneumatic Despatch is supremely simple. A length of air-cushion is taken, sufficient to stop the heaviest train. A special atmospheric pressure-gauge is connected with this portion of the tube containing it, as is also a cylinder and piston (P). Take the near end F, for example. While the exhaust is going on, the piston (*p*) is drawn towards the tube (*t*), and the valve it works closed. As soon, however, as the pellet-carriage has passed the grating, and the compression of air in the residual length of the despatch-tube commences, the increased pressure of air will lift higher and higher the piston-valve, and find escape. The engineer, therefore, screws down this piston-valve to a certain pressure of his pressure-gauge, and until this pressure is exceeded by the compression of the cushion or buffer of air, no escape will take place; but as soon as the compression of air does exceed the amount of air-pressure thus fixed by the judgment and experience of the engineer as necessary to properly stop his train, the surplus air above that blows freely off through the piston-valve. The skill attained by the engineer at the Euston Pneumatic station is very remarkable; and he not only knows accurately what pressure is wanted for a train of one, two, three, or more carriages, but he can judge exactly the differences between even individual carriages. Such niceties would never be necessary in working the pneumatic system on a grand scale. The time will come, we sincerely believe, when the projectors of this pneumatic method will be almost as highly regarded as those of our locomotives; and while we properly acknowledge their higher merits of design, we may well spare a line to record the deserved praise of the humbler individual who has

first practically manipulated the machinery entrusted to his charge. For more than two years the tube at his station has been at work, and more than a hundred mail-trains are daily blown or sucked through it.

If the form of the fan-wheel as seen in section may appear singular to observers, there is again a very simple reason for it—a reason apparent on the face of the plan. The interspaces of the fans being triangular, the air coming in at the centre would have room to spread as it passed outwards, and therefore would pass out in a broad, gentle current. What is wanted is high velocity of the wind thrown off, and equal distribution of it along the whole margin of the wheel. This is got by gradually diminishing the width of the wheel from centre to periphery, so that the broad central mass of air becomes more and more narrowed as it attains velocity and occupies the wider parts of the interspaces. Every particle is thus ejected with the highest possible momentum.

Nor is this mail-line the only example of the practical working of the system. It has been even still longer employed at the Central Telegraph Office in Moorgate Street, for the transmission of messages from and to the outer city stations, thus avoiding the delivery by messengers, and being more facile for such short distances than manipulating by the electric wires. Moreover, it possesses this by no means unimportant advantage,—the *actual* message, as *written by the sender*, is itself transmitted. The pipes at the Central Telegraph Office are all small—$2\frac{3}{4}$ inches in internal diameter—and double, being worked entirely by exhaustion. The pellets are cylinders made of felt or flannel, and about six inches long. The object of the double pipe is, that one pipe being always exhausted, the station at either end of the other pipe can, by turning on the connection, despatch a message. When one has to be sent, the electric telegraph bell is rung, calling the station at which it is to be received. The pellet containing the actual written message is then inserted into a slit in the despatch-pipe, and the covering-valve of the slit pressed to. The connection with the exhaust is then made, and the pellet sucked through. As it arrives at its destination, the exhaust is stopped, and the air in the terminal extremity of the pipe compressed by the motion of the pellet, opens the valve which the pressure of the atmosphere had held closed during the exhaust, and the pellet-parcel falls out.

But the latest phase of the utility of the Pneumatic Despatch has yet to be witnessed by the public, and will possibly have been seen by hundreds before these lines are perused by our readers. A large tunnel, 9 feet high by 8 feet wide—capable of containing the largest carriages of the Great Western

Railway—and a quarter of a mile long, has been built in the Crystal Palace grounds, for *passenger traffic*. The tunnel, which is of fine brickwork, with its closing valves, is already completed. The fan-wheel, 21 feet in diameter,—which will be temporarily worked by a fixed locomotive—is erected and enclosed in its plate-iron case; a model station has been formed, and the model carriage, built at Manchester, is at this moment in the grounds. It will be travelling in darkness, no doubt, or rather by lamp-light; but as the front head of the front carriage is sucked along by the exhaustion of the tunnel, the air will follow it instantly, and afford a plentiful supply of the life-supporting gas to the inmates of the carriages, while, just as the balloon, travelling at the same velocity as the currents of air which waft it, presents a perpetual calm to the aëronaut, no matter how rapidly it may progress, so the passengers by the Pneumatic Despatch will perceive not the least gusty effects from the gale which follows their passage closely up, or that torrent of air which, in the reverse method of propulsion, will blow them through in the opposite direction.

One cannot contemplate either the despatch of goods or passengers by this means, without perceiving the invaluable advantages which this method possesses for the underground traffic of our vast metropolis. Passengers will have as rapid transit as the locomotive affords, while they will experience nothing of the choking sulphurous vapours which the locomotives leave in our present underground railways. Moreover, one line of railway would be sufficient, and no collisions of trains could take place. Out of London, the locomotive would still be *the* engine for traffic of all sorts over large tracts of country. Again, for goods. To have our over-crowded streets relieved of much—perhaps of most—of their heavy traffic, and to have the thousands of tons now conveyed by weary horses, quietly and silently transmitted unseen beneath our roads and houses, will be indeed no slight boon. Still more, we may hope to see a network of smaller pipes traversing London and its suburbs, for the transmission of parcels. A parcel-post thus established will be almost as great a benefit as the Penny Postage.

It seems to me, also, that great advantage might be taken of the system, for effecting communications with or between military fortifications. Goods and men might be sucked through a tunnel of very great length; and if such tunnel were constructed at some considerable depth, it would be unassailable by an enemy. Gunpowder and stores so sent, could not be fired, captured, or destroyed; and although it would be a costly thing to make such a means of ingress and

egress for a distance of five, ten, or twenty miles, even such an expense might be worth its cost in actual warfare, while certainly in shorter lengths, within the region of a fortification, or between contiguous forts, it would undoubtedly have the highest claims to consideration. This, however, may be the last and least profitable of the many uses we shall see this system turned to.

We mentioned incidentally, in our opening pages, the "sighing" and "breathing" of the despatch-tube after its work. This is very curious. As soon as the carriages have passed the gratings of the Euston tube, a deep sighing begins, occasioned by the wind rushing in and out. If, for example, it be after an "exhaust," the air rushes violently into the tube, and, by its own impetus, crowds itself up and condenses itself within the tube, until its inherent elasticity reverses the current, and then an out-thrust of air takes place at such velocity that the tenacity and cohesion of the air within the tube is on the opposite hand pulled upon, and the new vacuum thus created again causes another sighing indraught of air. And so these waves of air sway to and fro, and in and out, for many seconds or even several minutes after the work of the tube is done, before quiescence is restored in its interior recesses.

Does not this incident hint how much more we have yet to learn of even the mechanical properties of air?

EXPLANATION OF PLATE.

Fig. 1. The Pneumatic Despatch Tube, with valves, V V′, at both ends.

Fig. 2. The fan-wheel and stationary engine.

Fig. 3. The fan-wheel, showing its central orifice at *c*, *c*, *c*, and the bearing-ring *d*, *d*, *d*, which works against the in-draught pipe, E.

Fig. 4. Section of fan-wheel in its inclosing case, showing its diminishing breadth from centre to periphery; the stationary engine, C, by which it is worked by the crank, *c*, and the shaft, *s s*; at K K and L L, the air enters from the in-draught chambers, E E′; and is thrown off at the periphery, *a*, *a*, *a*.

Fig. 5. One of the Euston pneumatic mail carriages.

Fig. 6. Section of Euston pneumatic pipe, with rails and carriage within it.

Fig. 7. End of Pneumatic Tube, showing by the increasing darkening of the tint the increasing pressure of air as the travelling carriage approaches the closed valve, V, and the effect of the piston, P, in allowing escape of air above the fixed pressure.

Fig. 8. The double exhausted Pneumatic Despatch Tube in use at the Central Telegraph Station in Moorgate-street; the exhaustion being continuous by a stationary engine at *e*; the parcels delivering themselves at the valves *a* or *c*.

THE WHITE RUST AND OTHER MICROSCOPIC FUNGI.

BY M. C. COOKE.

RECENT investigations, conducted by Dr. A. de Bary, on this and some other allied Fungi, have produced such important results, that it becomes necessary, in furtherance of our design to render familiar the structure and vegetation of these minute organisms, to devote ourselves to an explanation of what this eminent mycologist has done in extending knowledge in this direction. What is the external appearance presented by the "white rust" of cabbages, and allied cruciferous plants, is soon told. At the present season, and for two months past, it has, and continues to occupy the surface of the leaves and stems of the shepherd's purse (*Capsella bursa-pastoris*), with elongated narrow white spots like streaks of whitewash, and now the leaves of the goat's beard have commenced to be similarly infected. This has been called the "white rust;" and later in the season the leaves of cauliflowers and cabbages will become ornamented with similar patches, arranged in a circular manner, forming spots as large as a sixpence. Wherever these spots appear the plant is more or less deformed, swollen, or blistered, even before the parasite makes its appearance at the surface. These white pustules have a vegetative system of ramifying threads which traverse the internal portion of the plants on which they are found; these threads constitute what is termed the *mycelium*. Not only when the plant is deformed and swollen with its undeveloped parasite do we meet with the threads of mycelium in its internal structure, but also in apparently healthy portions of the plant, far removed from the evidently infected spots. These threads are unequal in thickness, much branched, and often with thick gelatinous walls filled with a colourless fluid. They creep insidiously along the intercellular passages, and are provided with certain appendages in the form of straight thread-like tubes, swollen at their tips into globular vesicles. These threads do not exceed in length the diameter of the mycelium which bears them. The appendages communicate in their interior with the mycelium and contain within them the same fluid, which at length becomes more watery, and the

terminal vesicles have their walls thickened, so as to resemble, on a casual observation, granules of starch. Dr. de Bary conceives that these appendages serve a similar purpose to the tendrils or suckers of climbing phanerogamic plants; *i.e.*, to fix the mycelium to the cells which are to supply the parasite with nourishment. As these appendages are always present, it is easy to discover the mycelium wherever it exists amongst the tissues of an affected plant.

The white pustules, already alluded to, contain the fruit of the parasite. Bundles of clavate, or club-shaped tubes, are produced upon the mycelium beneath the epidermis of the infested plant, forming a little tuft or cushion, each tube engendering at its apex reproductive cells, designated "conidia." These conidia appear to result in the following manner:—The tips of the clavate tubes generate them in succession. At first a septum, or partition, divides from the lower portion of the tube a conidium-cell; this becomes constricted at the septum and assumes a spherical shape, at length only attached by a short, narrow neck. Beneath this again the same process is repeated to form another and another conidium in succession, until a bead-like string of conidia surmount each of the tubes from which they are produced. At length the distended epidermis above is no longer able to bear the pressure of the mass of engendered conidia within, and is ruptured irregularly, so that the conidia easily separating from each other at the narrow neck make their escape.

As long since as 1807, M. Prevost described the zoospores, or moving spores, of these conidia, and his observations were confirmed by Dr. de Bary three years since, and now adverted to by him again in further confirmation. If the conidia (white spherical bodies ejected from the pustules of the "white rust") are sown in a drop of water on a glass slide, being careful to immerse them entirely, they will rapidly absorb the water and swell; soon afterwards a large and obtuse papilla, resembling the neck of a bottle, is produced at one of the extremities. At first vacuoles are formed in the contents of each conidium; as these disappear the whole protoplasm (granular substance within the conidium) becomes separated by very fine lines of demarcation, into from five to eight polyhedric portions, each with a faintly coloured vacuole in the centre. These portions are so many *zoospores*. Some minutes after the internal division, the papilla swells and makes itself an opening, through which the zoospores are expelled one by one, without giving any signs of movement of their own. They take a flat disk-like or lenticular form, and group themselves about the opening, whence they have been expelled, in a globular mass. Soon, however, they begin to move, vibratile

ciliæ show themselves, and by means of these appendages the entire globule oscillates, the zoospores disengage themselves from each other, the mass is broken up, and each zoospore swims off on its own account.

The free zoospores are of the form of a plano-convex lens, obtuse at the edge. Beneath the plane face, out of the centre, and towards that point of the margin which during the movement of the zoospore is foremost, is a disc-shaped vacuole, with two ciliæ of unequal length attached to its margin, the shorter cilia is directed forwards, and the longer in the opposite direction during the evolutions of the zoospores.

The zoospores are produced within from an hour and a half to three hours after the sowing of the conidia in water. They are never absent if the conidia are fresh, or even a month old, but beyond this period their artificial generation is very uncertain. This little experiment is a very simple and interesting one, and may be performed by any one who will take the trouble to follow out the above instructions.

From this simple experiment, let us turn for a moment to the plant in its natural condition when affected by the white rust. If, after rain or dew, when the little drops of moisture hang like pearls about the sickly pallid leaves of the shepherd's purse, bespattered with the white pustules of the rust, we collect and examine a drop of water from the immediate neighbourhood of one of the pustules, we shall commonly find empty conidia and zoospores in different stages of development.

Water alone seems to be essential to them, and for this the conidia may remain unchanged for a month, and literally burst into activity at the first gentle shower, till the whole surface of the plant is swarming with zoospores. We may no longer doubt that a true vegetable produces from itself bodies endowed with active motion, resembling low forms of animal life, and yet in themselves not animalcules, as some would suggest, but essentially vegetable, as we shall hereafter demonstrate. To scientific men this is not new, except as regards fungi, for in algæ such bodies have long been recognized.

A second kind of reproductive organs are described by Dr. de Bary; and if future examinations confirm his observations, as they doubtless will, this feature is an important one. It is true that M. Caspary long since detected similar bodies in moulds (allied to that which produces the potato disease), but he only knew *them* in a limited sense compared with what De Bary has revealed. These fruits are hidden amid the tissues of the plant on which the "white rust" is parasitic, and only betray their presence by the coloration of those tissues. To these bodies it is proposed to give the name of "oogonia" and "antheridia," on account of their

presumed sexuality, the "oogonia" representing the female, and the "antheridia" the male organs.

The oogonia are large sphærical or ovoid cells, with a thickish membrane containing a granular protoplasm, or formative fluid. They are produced either terminally or laterally upon the threads of the mycelium, from which they are separated by septa or partitions.

The antheridia are somewhat club-shaped or obovate cellules, considerably smaller than the oogonia, with slightly thickened walls and containing a finely granular protoplasm. These are produced upon branches of the mycelium which do not bear oogonia. The obtuse extremities of these branches, which are to be developed as antheridia, are applied to the surface of the growing oogonia, to which they adhere, become distended, assume their obovate form, and by the formation of a septum at their base, their contents are isolated from those of the threads of the mycelium, and thus the antheridia are perfected.

When these bodies have attained their full dimensions, the large granules which are contained in the oogonium accumulate at its centre, and form an irregular, somewhat spherical mass, which is called by De Bary a *gonosphere*. This gonosphere having been formed, a straight tube shoots out from the antheridium which perforates the wall of the oogonium, passes through the fluid which surrounds the gonosphere, elongating itself until it touches that body. From this period a membrane begins to be formed about the gonosphere, which thenceforth maintains a regular spheroidal form. It may be observed that the extremity of the tube which proceeds from the antheridium does not open, and the fecundation, if such it be, is produced solely by contact. After this contact of the two bodies the gonosphere acquires a new name, and is called an "oospore." The membrane which at first invests this organ is very thin, but by deposits from the surrounding fluid it attains to a greater thickness, and is at length of a yellowish brown colour, having its surface studded with large, obtuse warts. One of these warts, larger than the rest, forms a kind of thick sheath around the fecundating tube.

The oospores do not give evidence of any appreciable change for some months. For instance those collected by De Bary in June did not attain their ulterior development until the commencement of December. The method adopted was as follows:—Parts of the plants containing ripe oospores were preserved in the dried state. When examination was considered desirable, the portion to be employed was immersed in water for a day or two; it was then placed on a humid soil, or mould, covered with blotting-paper. The tissues enclosing the oospores were decomposed, and at the end of from four

to eight days their germination might be observed when placed in a drop of water. This method again corresponds with the ordinary processes by which the plant naturally decays on exposure to the influences of the atmosphere, and the oospores germinate under the favour of a shower of rain.

If the oospore, after the decay of the tissues, is isolated and placed in a drop of water, the brown investing membrane will be seen to rupture irregularly, and its contents (enclosed in a transparent inner membrane) issuing from the orifice. As in the case of the conidia, this body at first contains vacuoles, and is afterwards divided into polyhedric portions; these pass into zoospores which congregate at the centre into a globular mass. They afterwards separate, and for some minutes float about in the vesicle in which they were generated. Ultimately the membrane ruptures, and the zoospores swim about in the water just as those produced from the conidia had done. The number contained in each oospore is considerable, and may be estimated at not less than one hundred.

The zoospores, whether produced from conidia or from oospores, appear to be the same. The movements of both in the water last from two to three hours; then they cease, the ciliæ disappear, and the zoospores remain at rest, taking meanwhile a globular form. Afterwards these spores (for having ceased all motion they are no longer zoospores) emit a thin tube from some portion of their surface, such tube attaining a length of from two to ten times that of the spore whence it proceeds. The extremity of this tubes swells and forms a kind of cell into which the contents of the spore pass through the medium of the tube.

Thus far, and thus far only, has Dr. de Bary been enabled to trace the development of the zoospores in a drop of water. Another series of experiments was instituted by this mycologist having especial reference to the parasitism of the "white rust." He made numerous observations to ascertain whether the spores of the germinating tubes entered by the roots of growing plants, and satisfied himself that they did not. Plants of garden-cress, mustard, and shepherd's-purse had their roots immersed in water impregnated with zoospores. After one or two days, though the surfaces of the roots were covered with zoospores that had emitted their germinating tubes in all directions, none had penetrated or showed the least tendency to penetrate the epidermis. Other plants were planted in flowerpots and watered at the roots with water charged with zoospores, and for two days the pots were left standing in the water similarly charged, then the plants were removed, cultivated in the ordinary manner, grew up healthy, and gave no signs of the white rust. Care had been taken that neither

stems nor leaves should come in contact with water containing zoospores.

If a drop of water thus charged is placed on the surface of a living leaf of the shepherd's-purse, for instance, and left at rest for a few hours and examined minutely at the end of that period they will be found to have germinated. Let the epidermis be removed carefully and placed on a glass slide and submitted to the microscope. Many zoospores will be found to have produced from that point of their surface which is nearest to one of the stomata, or pores of the leaf, its slender tube, and to have thrust it through those openings, with the swollen extremity resting in the air-cavity situated beneath the pore. If many days, or even weeks, are allowed to pass, and the leaf is examined again, or another leaf similarly treated, and kept in a living and vigorous condition by remaining attached to the parent plant, still no further change or advance will be observed, the germs will appear fresh, and still in the same condition. Hence it is concluded that plants are not infected through the medium of their leaves.

If the cotyledons, or seed-leaves, are watered with similarly impregnated water, a different result has been observed to take place. The germination of the tubes till their entrance at the stomata is the same, but, having entered, the swollen extremity elongates, becomes branched, and takes all the appearance of mycelium such as we at first described. If the infected plant endures through the winter the mycelium endures with it, to recommence vegetating in the spring.

The experiments which Dr. de Bary performed were all upon plants of the common garden-cress. If will be unnecessary to repeat the details of these, as given in the memoir recently published on the subject, but it will suffice to give a summary of results. In two series of plants cultivated at different periods from good seed, one hundred and five plants which had not received the water impregnated with zoospores upon their cotyledons vegetated without any indications of the parasite. Amongst the eighteen plants which were inoculated by watering the cotyledons, four only were not attacked by the parasite, fourteen bore the "white rust." In six of these it did not extend beyond the cotyledons, in the others it also appeared on the stems and leaves.

From these experiments it may be deduced that plants are not infected by spores of the parasite entering at the roots, or by their leaves, but that inoculation takes place through the medium of the cotyledons or seed-leaves; that the agents in this inoculation are the zoospores produced either from the conidia or the oospores; that they do not enter the stomata or pores themselves, but thrust out a germinating tube into the extremity of which the contents of the zoospores pass;

that when these tubes have entered the stomata of the cotyledons they branch and ramify, becoming a true mycelium, from which fruitful parasites are developed; that if a plant so infested lives through the winter the parasite lives with it to vegetate again in the spring.

The immense number of zoospores capable of being produced from a single infested plant is almost beyond calculation. It is easy for a million of conidia to be developed from such a plant, each producing from five to eight zoospores, besides a large number of oospores each containing a hundred zoospores. It can scarcely be considered marvellous that the white rust should be so common on plants favourable to their development, the marvel being rather that any plant should escape.

Until recently it was doubtful whether more than one or two species of *Cystopus* (white rust) were known. It is now certain that we have two in Great Britain, and five or six others are found elsewhere. Of the British species one is found on many cruciferous plants, as the shepherd's purse, garden-cress, mustard, radish, and plants of the cabbage kind. This is the *Cystopus candidus*. Another occurs on the goat's-beard, salsify, and scorzonera, which is called *Cystopus cubicus*. Both have great external resemblances, but both possess specific internal differences. In the goat's-beard rust the terminal conidia in the bunches or fascicles of conidia which are produced within the pustules are spheroidal, large, and of a yellow-brown tint, whilst the residue are cylindrical, smaller, and more or less compressed. In the crucifer rust the conidia are all equal in the pustules and globose. The oospores in the former of these are subglobose, and the warts on their surface are solid; whilst in the latter the oospores are truly globose, and the warts on the surface are hollow. Of the other species it is not improbable that one or two, perhaps three, may yet be found in this country. Without attempting to indicate their microscopic differences, it may be serviceable to name the species of phanerogamic plants on which they are likely to be found. The purslane white rust (*Cystopus Portulacæ*, D. C.) should be sought on the purslane, which, though of limited cultivation, is exceedingly liable to attack from this parasite. The sandspurry white rust (*Cystopus Lepigoni*, D. By.) may perhaps be found on the common sandspurry * (*Spergularia rubra*); and the thistle white rust (*Cystopus spinulosus*, D. By.) may probably be met with on the leaves of the common thistle (*Cnicus arvensis*) or some of its allies.

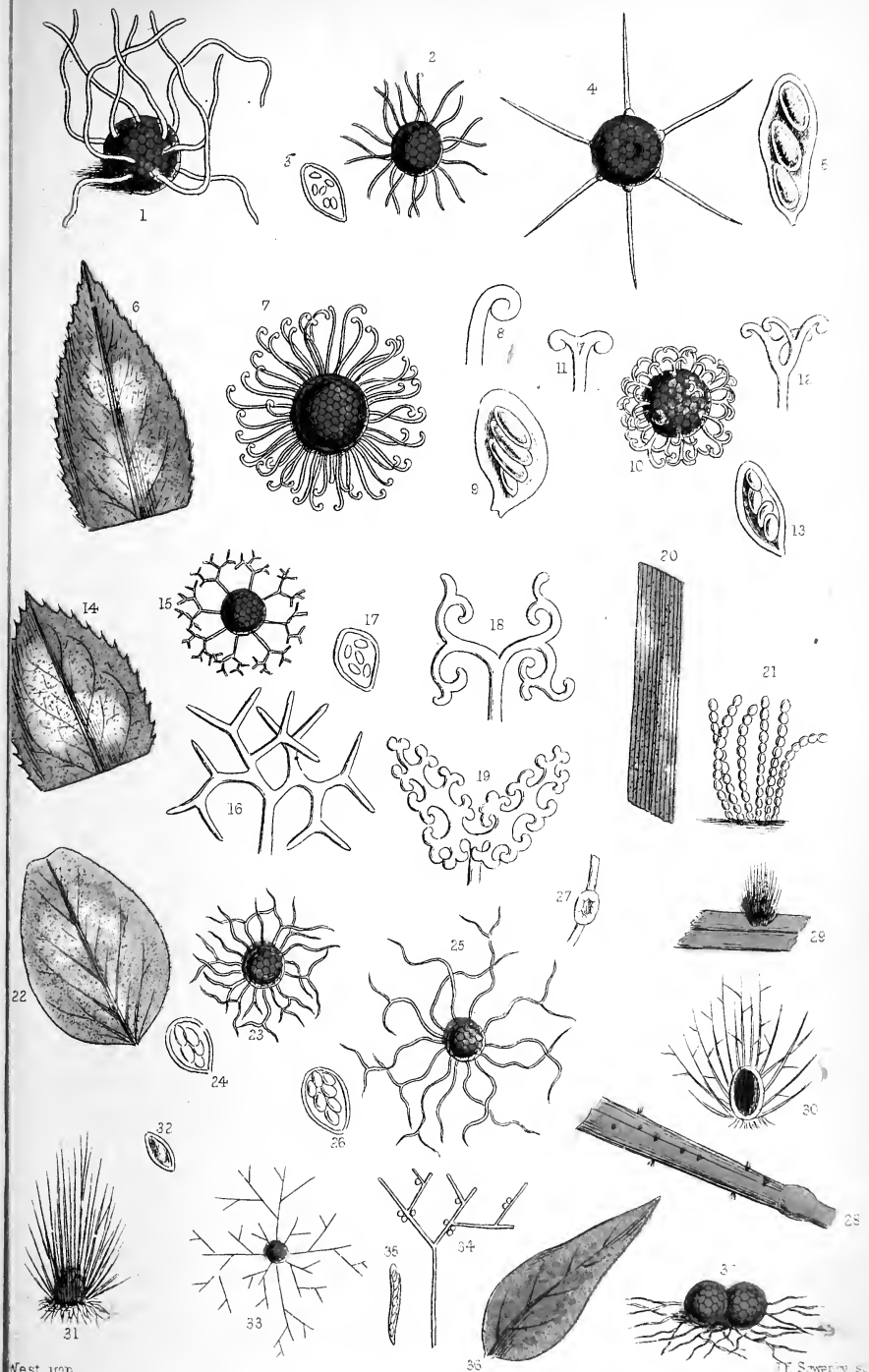
Considerable interest is now attached to these parasites,

* Whilst this paper was passing through the press, I saw British specimens of this species also collected as a variety of *Cystopus candidus* last autumn.

which, as far as we at present know, differ materially in their reproduction from the other dust-like or uredinous fungi with which they have long been associated. Dr. de Bary proposes the union of these with the mould-like fungi of the genus *Peronospora* (to which the mould infesting the potato belongs), so as to constitute by themselves a group apart from the genera with which both have heretofore been associated. Whether his views will be accepted by mycologists time will speedily prove. Under any circumstances microscopical and botanical science will reap considerable benefit from his researches.

WHITE MILDEWS OR BLIGHTS.

Notwithstanding the inconvenience to ourselves of calling very different fungi by the same common name of "mildew," the popular mind does not recognize the inconvenience, since it scarcely troubles itself to inquire whether they are not all the same thing. In obedience to this custom we again write of "mildew," or "blight," as it is called in some districts, but of a very different kind to that which is so detrimental to growing crops of corn. In the present instance it is our intention to illustrate a group of fungi which are exceedingly common, and which differ greatly in appearance and structure from any to which we have had occasion to allude. To obtain a general knowledge of these forms let our reader proceed at once to a clump of rank grass: if it be his fortune to dwell in the country, the walk of a few yards will suffice. Let him examine this clump more carefully, perhaps, than he has been accustomed to do, and we venture to predict that he will find some of the leaves covered with what appears to be a dirty white mould, or mildew. One of these leaves should be collected as carefully and conveyed to the microscope as speedily as possible, taking care not to touch or brush it against any other object so as to disturb the arrangement of the delicate little threads upon its surface. If a small portion, say about an inch, be cut from this leaf with a sharp pair of scissors, and laid upon a slide, or pinned down upon a strip of sheet cork so as to keep it flat and then submitted to examination under the microscope, with an inch power, a beautiful forest of crystalline vegetation will be observed. If the examiner on this occasion should not possess a binocular microscope we are sorry for him, because in that case he will not see all that is to be seen under the greatest advantages. If we ever truly enjoy looking through such an instrument it is on an occasion like this, when a low power is all that is needed and the object is required to be seen in relief. It is scarcely possible to convey an adequate idea of the beauty of such a scene as the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Blights

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microscope reveals upon this fragment of grass-leaf. Little bundles of delicate threads, clear and crystalline, are seated upon a branching slender mycelium. These threads, sometimes erect, sometimes drooping, flexuous, or prostrate, are composed of numerous roundish or spherical cells attached to each other in a moniliform or bead-like manner (fig. 21). These easily separate from each other. Let a portion of the threads be removed from the leaf on the point of a lancet and laid upon a glass slide, with a thin cover over them. Submit this object to a quarter-inch power as a drop of water is let fall at the edge of the cover and insinuates itself, by capillary attraction, between the two plates of glass. So soon as it touches the moniliform threads the disunion commences, and almost before they are enveloped in the fluid two spherules will scarcely remain attached to each other. This delicate little mould on the grass leaf at one time bore the name of *Oidium monilioides*. It is now regarded only as a condition of another minute fungus, to which attention will shortly be directed.

The vine disease so fearfully destructive on the Continent, and not altogether unknown in this country, is another of these incomplete fungi. From the individual who first discovered it in the South of England, it was called *Oidium Tuckeri*, which name it continued to bear, both here and abroad, until with many others, probably nearly all, of the same genus it was found to be only a barren state of, what is called by mycologists, an *Erysiphe*. If, towards the autumn, we should again collect some whitened, mouldy, or mildewed grass-leaves, similar in appearance to those mentioned above, and carefully look at them with a pocket lens, little black points, almost as small as a pin's point, or more resembling the full stop with which this sentence closes, will be found scattered over the white threads. The aid of the microscope must be again sought to make out the structure of the little black dots. Closely nestling upon the mycelium, the little points will prove to be spherical, brownish conceptacles, surrounded with transparent floccose appendages. Many other species are far more beautiful than that of the grass leaf, as will be seen by reference to our plate. The variation consists chiefly in the form of the appendages which spring from the conceptacle and surround it in a radiating (as in figs. 4, 7, 10, and 15), or in a more or less confused and entangled manner (as in figs. 1, 23, and 25). The surface of the conceptacle is minutely reticulated, and its base is attached to the mycelium. When first formed, these globose conceptacles are almost colourless; they afterwards acquire a yellow colour, and are ultimately of a deep brown. The appendages are seldom at all coloured. Within the conceptacle are contained from one to several transparent obovoid sacs, or spore-cases called *sporangia*,

enclosing a definite number of spores (figs. 3, 5, 9, 13, &c.), which vary in different species. In the hazel mildew, for instance, there are two spores in each *sporangium;* in the willow mildew, four; in the maple mildew, eight; in the grass mildew, and some others, numerous. The tips of the appendages are variable, and often elegant (figs. 8, 11, 12, 16, 18, and 19), sometimes simple and at others symmetrically branched. All the species occur on the still living and green parts of plants, especially the leaves, and are therefore truly parasitic. A pocket lens will show whether any conceptacles are present on any suspicious leaf which may be collected, but high powers of the microscope are essential for their complete examination. It is during autumn when vegetation begins to languish, that we shall be most successful in searching for specimens. They will then be found almost everywhere, and the white mycelium forms an object too conspicuous for them to be readily overlooked. Botanically, nearly all the species were at one period included in one genus, under the name of *Erysiphe*, a name derived from the Greek, and signifying "mildew;" at the present time they are distributed through several genera, the chief distinctions of which are based upon the form of the appendages. Though personally disposed to question the generic value of such distinctions, it would be imprudent to adopt any other names here than those to be found in recent English works on fungi.

The first species in our enumeration is found on cultivated roses. What a deplorable picture does a favourite rose-bush present when attacked by this mildew? The leaves blistered, puckered, and contorted; their petioles and the peduncles and calyces of the flowers swollen, distorted, and grey with mould; the whole plant looking so diseased and leprous, that it needs no mycologist to tell that the rose is mildewed. The conceptacle in this species is minute and contains but one sporangium, which is one of the characters of the genus in which it is now included, and a more justifiable distinction than the ramifications of the appendages. The mycelium is rather profuse, and the threads or appendages which spring from the conceptacle are simple and floccose (fig. 2). The sporangium contains eight ovate spores. This species (*Sphærotheca pannosa*), in its oidioid or conidiiferous form was for some time known under the name of *Oidium leucoconium*.

An allied species constitutes the hop-mildew, a visitation with which some of our Kentish friends are too familiar. This is not a prejudiced species in the choice of its habitation, since it is found on many other plants, where it flourishes with equal vigour. The meadow-sweet, burnet, scabious, teasle, dandelion, and other composite plants, plantain, and plants of the cucumber

family, all suffer more or less from its roving disposition. The mycelium of whitish threads is even more conspicuous than in the last species, but the conceptacles are often not to be found at all. These are also very minute and most common on the under surface of the leaves. The appendages, or fulcra, are simple, floccose (fig. 1), and coloured. The sporangia are found singly in each conceptacle, and each sporangium contains eight spores.

An autumnal stroll amongst hazel-bushes, when the nuts are ripe, will lead, if the nuts are not a greater attraction, to the discovery of whitish patches on the under surface of the leaves, caused by the mycelium of the hazel mildew (*Phyllactinia guttata*, Lev.) These patches are less distinct and conspicuous than in many other species, but the little blackish dots of the conceptacles may be distinguished by sharp eyes without the use of the lens. Though possessing a decided preference for the hazel this species is also found on the green leaves of the hawthorn, ash, elm, birch, sallow, beech, oak, and hornbeam. The conceptacles are larger than in the two preceding species, and somewhat depressed above. The appendages are few (fig. 4), radiating, rigid, and acicular, or like needles. Each conceptacle contains eight or more sporangia, and each sporangium has from two to four spores (fig. 5). This species being very common, its conceptacles large, and produced copiously, and its appendages distinct, it will prove a good type with which the student of these fungi may commence his examinations. This is the only representative which we possess of the genus established by M. Leveille for such of the *Erysiphei* as have the conceptacle depressed, and the appendages rigid and simple, by which features it is distinguished from genuine species of *Erysiphe*.

Two species, also common, having many features agreeing with each other, are found on the leaves of the maple and the willow. The willow blight (*Uncinula adunca*, Lev.) is found irrespectively on various species of poplar and willow (fig. 6). In size and external appearances, to the unaided eye, it seems scarcely to differ from the preceding, but more minute examination will show that in the appendages there is an appreciable difference. Still rigid, but no longer aciculate, the tips bent or curved like a little hook, or curled upon themselves (fig. 8), radiating and numerous (fig. 7), and at length tending upwards. Many sporangia are contained within each conceptacle, each of which is furnished with four spores. The amateur must not be disappointed, if, on examining mature conceptacles with a view to the discovery of the sporangia, he finds only free spores. The membrane of the sporangia is very delicate, and disappears generally as the spores are matured.

The "blight" or "mildew" which occurs on the common hedge-maple, as well as on the sycamore leaves, is exceedingly conspicuous when occurring on the former plant. The whole bush often presents a hoary appearance as if sprinkled with powdered chalk. In the spring, the under surface of the leaves of the same plant are liable to become hoary from another cause. The whiteness occurs in patches, has often a pinkish or violaceous tint, and glistens like hoar frost. This affection of the leaves was, at one time, believed to be produced by a fungus which was called *Erineum acerinum*, but now it is regarded as a diseased state of the tissues. In the maple mildew, both surfaces of the leaves are alike affected, and the little, dark, point-like conceptacles will be found studded over both. It is not uncommon to meet with very white leaves, caused by the mycelium, but which bear no fruit. The appendages in this species are shorter than in the last (fig. 10), and the tips are bifid (fig. 11), or divided into two short branches, each of which is bifid, and uncinate or hook-shaped (fig. 12). The conceptacles contain not less than eight sporangia, each of which encloses eight spores.

Amongst the parasites that prey upon the much-abused berberry (which has been charged in turn with producing the mildew in corn), is one which causes the green leaves to assume a chalky appearance (fig. 14), though less conspicuously than in the maple blight. This parasite is the berberry mildew (*Microsphæria berberidis*, Lev.). In such localities as the writer has met with the berberry suffering from mildew, he has invariably found a larger proportion of leaves with the barren mycelium than of those on which the conceptacles were developed. Perhaps in other localities this may not be the case. The appendages, as will be seen on reference to our plate, differ materially from any of those to which we have referred; indeed, this genus (or sub-genus) has the most elaborate and beautiful forms in these appendages of any of the Erysiphei. A figure is given of the tip of a fulcrum from a continental species (*M. Ehrenbergii*, Lev.), not yet found in this country (fig. 18). In the berberry blight the appendages are straight at the base, but afterwards become forked, each fork being again forked, and these yet again branched in a similar manner (fig. 16); so that a complex dichotomous tip is formed to each of the appendages (fig. 15). Each conceptacle contains about six sporangia, and each sporangium contains from six to eight spores (fig. 17).

The common gooseberry is also liable to a visitation from an allied species, in many respects closely similar, but differing in having the tips of the appendages more branched, and the extremities of the ultimate branchlets are not entire and at-

tenuated, as in the berberry mildew; but divided into two tooth-like processes. The conceptacles in this species contain from four to eight sporangia, each of which has four or five spores.

In England, the leaves of the guelder-rose, and in France (perhaps also in this country) those of the alder, nourish a parasite belonging to this division. This "blight" possesses so much in common with others to which allusion has been made, that it will scarcely be necessary to describe it in detail. A figure of the tip of one of the appendages of the variety found on the alder (fig. 19), is given in the plate.

Since the illustrations to this paper were engraved, we have found another species which had not been before noticed in this country (*M. Hedwigii*, Lev.), on the leaves of the mealy guelder-rose in the vicinity of Darenth wood, near Dartford, in Kent. The mealy character of the leaves of this plant, and the minute size of the conceptacles of the parasite, render it difficult to find; indeed, it could not be noticed unless it were sought for, as we sought it, lens in hand. It only occurs on the under surface of the leaves: the mycelium is very web-like and fugacious, the conceptacles minute, globose, and scattered. Four sporangia, each containing but four spores, are enclosed in each conceptacle, which is surrounded by a few appendages (about six) thrice dichotomous, and thickened at the tips of the ultimate branches, which are incurved.

The species of true *Erysiphe* are distinguished botanically from the foregoing by the floccose character of the appendages, in which feature they accord with the species found on the rose and the hop, but from which they differ in the conceptacles containing numerous sporangia instead of only one as in those species.

One of the most common and conspicuous of these is found on the leaves, and leaf-like stipules, of the garden pea. Every leaf in a crop will sometimes suffer, and the gardener, to his great mortification, finds that the mildew is more prolific than his peas. The leaves become sickly and yellow as the mycelium of the fungus spreads over them, when they present a peculiar appearance, as if growing beside a chalky road in dry dusty weather and had become covered with comminuted chalk. Soon the conceptacles appear, profusely scattered over the white threads, like grains of gunpowder (fig. 22), and after a brief struggle for existence the pea and its parasite die together. In this species (*Erysiphe Martii*, Lev.), the appendages are nearly transparent, short, and much interwoven with the mycelium (fig. 23), the sporangia globose containing from four to eight spores (fig. 24). It is not confined to peas, although that habitat has been here given for it, because it is so common upon them. Beans, melilot, St. John's Wort, some

umbelliferous plants, and the meadow-sweet have all been found affected.

The species found on grasses, especially the cocksfoot, has been already alluded to. The conceptacles contain from twenty to twenty-four ovate sporangia, each enclosing eight spores. The appendages and mycelium are much interwoven.

Another of these "white mildews," not only on account of its frequency of occurrence on certain plants, but also from the numerous species of phanerogamous plants on which it is found (fig. 25), may be truly designated "common" (*Erysiphe communis*, Lk.); many kinds of crowfoot, especially *Ranunculus acris*, are subject to its parasitism. It is found also on other plants of the same natural order, on the rest-harrow, trefoils, enchanter's nightshade, bindweed, and knotgrass. There are from four to eight sporangia in each conceptacle containing from four to eight spores (fig. 26). In this species, more especially, M. Tulasne found curious sucker-like processes developed on the threads of the mycelium (fig. 27); their office may probably be only that of attachment.

Of the other species found in Britain an enumeration will suffice, since they contain no feature of interest to the microscopist; and all the members of this section are far less beautiful than those in other genera (especially *Microsphœria*).

The leaves of the dogwood or cornel are the home of one species (*E. tortilis*, Lk.), and the burdock of another (*E. Montagnei*, Lev.); both of these in addition to the above have sporangia which contain more than two spores. There are also two species in which only two spores are contained in each sporangium. One of these (*E. Linkii*, Lev.) is found on both surfaces of the leaves of the mugwort; the other (*E. lamprocarpa*, Lev.) occurs on salsify, scorzonera, weasel-snout, and plantain.

These complete the *Erysiphei*, but there are allied species of too much interest not to be noticed in connection with them. Before doing this we will, for the benefit of the botanical microscopist, append a brief view of the characters of the groups already reviewed.

Conceptacle with one Sporangium—	
Appendages floccose	*Sphærotheca.*
Conceptacle with many Sporangia—	
Appendages needle-shaped	*Phyllactinia.*
Appendages hooked	*Uncinula.*
Appendages dichotomous	*Microsphœria.*
Appendages floccose	*Erysiphe.*

Three very singular fungi are found on damp straw and paper, two on the former and one on the latter. Of the

species occurring on straw, the most common one is figured, natural size, in our plate (fig. 28), but from this no idea can be formed of its structure, which in some points resembles an *Erysiphe*. The conceptacles are thin and brittle, and are clothed externally with long dark-coloured branched hairs (figs. 29, 30), which are curiously scabrous with rough minute points, arranged in transverse lines. The conceptacle contains long, narrow sporangia, each enclosing dark, almost black, lemon-shaped sporidia. For low powers this is a very interesting object. The minute structure affords no feature of popular interest. This fungus (which bears the name of *Chætomium elatum*) is common on old straw thatch, matting, &c., resembling small brown tufts of hair, visible to the naked eye.

Paper much exposed to damp will occasionally develope a similar "bristle-mould," surrounded by a yellowish spot (*Chætomium chartarum*, Ehrb.); but it is not so common as the last. In habit and structure it is very similar (figs. 31, 32).

In 1838, the Rev. M. J. Berkeley announced the discovery by him of a singular production, for which he was unable to find a fitting location in any genus then established, and for which he accordingly characterized a new one, under the name of *Ascotricha*. This new species of paper mildew was found by him on some printed paper in a box. It somewhat resembles the other species above alluded to at a casual glance, but more minute examination will reveal its differences. The author to whom we are indebted for this species thus describes its development. At first it appears as a minute branched mould interspersed with globose brownish conidia. As it advances in growth, globose black conceptacles become visible amongst the threads, clothed with and supported by alternately branched obscurely-jointed filaments, the branches of which generally form an acute angle with the stem (fig. 33). The ramification of these is very peculiar, the stem and main shaft of each subdivision being almost constantly shortened and surmounted by the branches given off near its apex; this, again, is often abbreviated and another branchlet given off, which again surpasses it, and occasionally the same circumstance takes place a third time. The apices are clavate and colourless; the rest of the filaments, when viewed by transmitted light, brown, even, and pellucid; a few globose conidia are usually attached to them (fig. 34). The conceptacle is thin, black to the naked eye, of an olive-brown under the microscope, filled with a mass of linear extremely transparent asci (fig. 35), each containing a single row of broadly elliptic chocolate sporidia. These have a paler border; sometimes the colour entirely vanishes, either from age or abortion, and

there is only a minute globose nucleus or more probably a vesicle of air, in the centre; occasionally they become so transparent that the globular bodies alone are visible. After the conceptacles burst several are frequently collected together into an irregular linear body, which consists principally of the conglomerated sporidia.

One other very common and troublesome little fungus will for the present close our examples. This is found creeping over dried plants preserved in herbaria, on decaying fruit, preserves, and various other substances, sometimes animal as well as vegetable, but chiefly the latter. To the naked eye it appears as a myriad of little yellow spherical bodies, of the size of very small pins' heads, resting upon fine cobweb-like threads (fig. 36). When magnified the surface of the conceptacles is seen to be reticulated (fig. 37). In the interior the sporidia are borne, contained also, as in the former instance, in asci. It has been considered *probable*, but, as yet, not fully proved, that this mildew is a compound fruited (ascigerous) condition of an equally common mould (*Aspergillus*).

All the leaves containing the above-named species of fungi may be dried and preserved for future examination, either between folds of blotting-paper or the leaves of an old book. They will generally be examined to the greatest advantage in the fresh state, but if too much pressure be not employed in the drying, it will not be difficult, even in that condition, to make out their characteristic features. Care must be taken, by changing their position, that moulds of other kinds do not establish themselves upon the specimens in drying, or that when dried they do not fall a prey to *Eurotium herbariorum*.

For the present, at least, we are about to bring these papers on Microscopic Fungi to a close. Already we fear that some subscribers will have thought our story of rust, brand, and mildew interminable, and looked anxiously for the announcement just made. On the other hand, we would flatter ourselves into the belief that others have made a new acquaintance with these minute and mysterious forms, and would fain know more. The groups of fungi which we have endeavoured to illustrate have, with but few exceptions, one feature in common, *i.e.*, that they are parasitic on living plants. These constitute but a small portion of the microscopical species found in this country. To the elegant forms of mould which inhabit decaying vegetable substances no allusion has been made. These constitute a fairy flora of forests and gardens with features as varied and fruits as multiform as those of the trees and flowers of the earth. The numerous, and often marvellous, phases of low life developed upon dead leaves and rotten sticks, would in description occupy a far greater space

than we have devoted to our subject. Yet for all these we have not spared so much as a passing word. The treasures still left unopened are far richer than even those we have revealed. The gates of another world have been thrown open, but we have scarcely passed the threshold. A minutely and elaborately illuminated page of the book of Nature has been turned, and we have only perused a single line. We might traverse the primeval forests of the new world and explore the unknown regions of the old, and not encounter so much to excite our admiration or cause our wonder as lies about our feet at home; marvels which we tread beneath our feet, or kick from our path, because they appear to be only rotten sticks, withered grass, and decaying leaves. All this may appear as the dream of an enthusiast, or the ravings of one on whom the moon has shone too often. When Columbus spoke of a new world beyond the seas, which he longed to seek and explore, some believed him duped and others called him mad. We write of no chimerical El Dorado, we speak of no undiscovered world, and yet we seem to allude to wonders still unknown, because so few have had the courage to venture upon the journey for themselves.

In sober earnestness, however, let us commend this pursuit to all who possess a microscope and leisure to use it. It may be for a time the "pursuit of knowledge under difficulties," on account of the condition of our literature on this special subject; but many workers will produce more readers, and good books will come when there are more to purchase and appreciate. It is not improbable that in more cases than have come under our own observation, microscopists, wearied of diatoms and allied forms, or deeming themselves in possession of all that is novel or interesting in this direction, are seeking for a new field of labour, and a new subject to kindle up a new enthusiasm. To these we have advised, and to any more such we continue to advise, that fungi should have a fair trial. If variety be desired, here they will have at least 2,000 species for a knowledge of which the microscope is essential. If they thirst for discovery, let them be assured that here also the earnest worker is sure to meet with such a reward. Or if they would acquaint themselves with the manifestations of Divine power as developed in the most minute of created things, let them follow such observers as Tulasne and De Bary, and seek the "why and wherefore" of the phenomena of mycetal life.

If there should still be any hesitation whether there is in this pursuit sufficient of the element of variety for those who do not desire to pursue the subject into its deepest scientific recesses, to render it available for them, let them go to a good public library, such as that of the British Museum, and inquire

for the large illustrated work by Corda, entitled "Icones Fungorum," or the more recent volumes by Tulasne (Selecta Fungorum Carpologia), and examine the figures of microscopic fungi in either of those works, and decide for themselves.

EXPLANATION OF PLATE.

Fig. 1. Conceptacle of Hop mildew (*Sphærotheca Castagnei*), magnified.
„ 2. Conceptacle of Rose mildew (*Sphærotheca pannosa*).
„ 3. Sporangium of the same.
„ 4. Conceptacle of Hazel mildew (*Phyllactinia guttata*).
„ 5. Sporangium of the same.
„ 6. Leaf of white willow infected with the Willow mildew (*Uncinula adunca*).
„ 7. Conceptacle of Willow mildew (*Uncinula adunca*).
„ 8. Extremity of one of the appendages, further magnified.
„ 9. Sporangium of the same.
„ 10. Conceptacle of Maple mildew (*Uncinula bicornis*).
„ 11 & 12. Extremities of two of its appendages, further magnified.
„ 13. Sporangium of the same.
„ 14. Leaf of Berberry affected with the Berberry mildew (*Microsphæra berberidis*).
„ 15. Conceptacle of Berberry mildew.
„ 16. Tip of one of the appendages.
„ 17. Sporangium of same.
„ 18. Tip of appendage of a Continental species (*Microsphæria Ehrenbergii*).
„ 19. Tip of appendage of Alder blight (*Microsphæria penicillata* var. *Alni*).
„ 20. Piece of grass-leaf mildewed with *Oidium monilioides*.
„ 21. Tuft of conidia of *Oidium monilioides*.
„ 22. Leaf of garden Pea, with Pea-mildew (*Erysiphe Martii*, Lev.).
„ 23. Conceptacle of Pea-mildew.
„ 24. Sporangium of the same.
„ 25. Conceptacle of common mildew (*Erysiphe communis*) from leaf of Buttercup.
„ 26. Sporangium of the same.
„ 27. Sucker on the mycelium of *Erysiphe communis*.
„ 28. Piece of straw with bristle-mould (*Chætomium elatum*), natural size.
„ 29. Conceptacle slightly magnified.
„ 30. Section of same, further magnified.
„ 31. Conceptacle of paper bristle-mould (*Chætomium chartarum*) magnified.
„ 32. Sporidium of the same.
„ 33. Conceptacle of paper mildew (*Ascotricha chartarum*), magnified.
„ 34. Portion of thread of same, with conidia.
„ 35. Ascus, or sporangium, and sporidia.
„ 36. Dead leaf overrun with the herbarium mildew (*Eurotium herbariorum*).
„ 37. Conceptacles of the same, seated on their mycelium.

THERMOMETRY.

OF the various philosophical instruments which are met with in the hands of that remarkable body "the general public," it may certainly be said that none is so widely known as the Thermometer; perhaps widely disseminated would be a preferable expression, for it may be doubted whether one in ten of those who use these instruments know anything about their theory or practical nature.

Meteorology as a science has made great strides during the last few years; that it has substantial claims on our attention for sanitary reasons is now pretty generally conceded, and that the weather has much to do with the public health few will now be found bold enough to deny. Under these circumstances it does not seem unappropriate to call the attention of the readers of the Popular Science Review to it; and of its practical branches few are more interesting than that relating to the measurement of temperatures, which will form the subject of the present paper.

Any discussion as to the physical character of heat, as to its general relations, would be not only beside the object we have now in view, but would require a whole volume for its due consideration. We must be content to take heat as we find it, and see how it can be approached so as to deduce facts calculated to be of a useful character. We can obtain crude ideas in reference to it in a variety of ways. For philosophical purposes, the expansion it universally causes in all natural substances affords an easy and convenient method of estimating it in a relative sense. Everybody knows by experience that a pair of boots which are a perfect fit in the month of January, if *get-on-able* in July, can only be worn with greater or less inconvenience and discomfort. Why? The reason simply is, that the natural heat of the summer season causes an increase in the bulk of the foot, and this can only be accommodated by an enlarged boot, except the wearer make up his mind to endure torture for fashion's sake, as many in fact do. Another familiar effect of heat is well known to the laundress. Her "box-iron" has its heater made much smaller than the case, in order that the former, when made red-hot to subserve

the purposes of her calling, may yet be able to enter the latter. We might multiply illustrations of this kind to an indefinite extent, but the above are sufficient as an introduction to the general proposition which we would here lay down; viz., *That whereas all bodies whatsoever expand by heat and contract by cold, thermometry is the art of applying the known expansion and contraction of one body, in such a way that it may serve as a standard of reference with which to compare the expansion and contraction of other bodies.*

A subtle physicist might find fault with this enunciation; a lawyer might say, You rush headlong into an assumption without adequate proof. We should reply to the latter, that our object is to apply facts, and not to argue; and we should hope to disarm the former by saying that it was our desire to divest the matter of rigid and dry technicalities.

The same body always has the same volume at the same temperature, and always suffers the same change of volume with the same change of temperature. Since volume and change of volume admit of the most exact measurement, they become a very convenient means for determining the change which takes place in the temperature of any body. Although all bodies are susceptible of dilatation and contraction by changes of temperature, yet all are not equally fitted for thermometrical purposes: for many reasons, some of which will presently be adverted to, mercury is found to be best adapted for the purpose. We shall therefore commence with a description of the simple mercurial thermometer.

This instrument consists in its ordinary, or, as we may call it, its typical form, of a capillary glass tube from eight to fifteen inches long; to one extremity of which (which, when mounted, becomes the lower extremity) a glass bulb is blown, the bulb and part of the tube being filled with mercury. When such a tube is exposed to an increase of temperature, the glass and the mercury contained in it will both expand. If these expanded in the same proportion, the capacity of the bulb and tube would be enlarged in the same proportion as the mercury in them, and consequently the level of the mercury in the tube would remain unaltered. If, however, the expansion of the bulb and tube be different from that of the liquid metal contained in them, the level of the column in the tube will, after expansion, stand higher or lower than before, according as the expansion of the mercury is greater or less than the expansion of the bulb and tube.

It is found by experiment that the dilatability or expansive power of mercury is greater than that of glass in the proportion of nearly 20 to 1; and, consequently, the capacity of the bulb

and tube will be less enlarged than the volume of the mercury contained in them in the proportion of nearly 1 to 20; therefore, for the reason above stated, every elevation of temperature by which the tube and the mercury would be affected, will cause the column of mercury to rise in the tube, and every diminution of temperature will cause it to fall.

The space through which the mercury will rise in the tube, by a given increase of temperature, will be greater or less according to the proportion which the diameter of the tube bears to the capacity of the bulb. The smaller the proportion of the one to the other, the greater will be the elevation of the column produced by a given increase of temperature; for a given increment of temperature will produce a definite increase in volume in the mercury, and this increase of volume will fill a greater space in the tube, in proportion to the smallness of the bore of the tube compared with the capacity of the bulb.

Such an instrument, without anything additional attached to it, would merely indicate, if a change of temperature took place, the simple fact of there being an alteration. To render it useful for the purposes of science, it is necessary that the tube should be provided with some contrivance from which exact numerical indications of the amount of the changes might be derived. A graduated scale is therefore attached to the thermoscopic tube previously described, and we then possess a thermometer of the simplest form in use. Of course, in the actual construction of thermometers there are precautions to be attended to, which need not be adverted to here.

In making a thermometer, it is not indispensable that mercury should be used; air will, in many cases, answer the purpose. From the delicacy of its indications, and the regularity of its expansion, air would seem to be the material best fitted for measuring changes of temperature, and, indeed, it was the substance first used. The early *air-thermometer* consisted of a simple glass tube, having attached to it at one end a bulb, the other dipping into some liquid contained in a vessel below; as the bulb became heated, the included air expanded and forced down the liquid in the tube; as it cooled, the air contracted, and the liquid rose; a scale attached gave the amount of the corresponding variation in temperature. But the inconvenient size of the instrument, and the extreme delicacy of its indications, together with its limited range, impaired its utility. It was also found that differences of atmospheric pressure, entirely independent of temperature, caused an alteration in the bulk of the air: these, and other circumstances combined, ultimately led to its falling into disuse.

The first great improvement in the thermometer was made by the Florentine Academicians; they substituted the expansion of a liquid for that of air, employing spirits of wine for the purpose, and they divided the tube of the instrument arbitrarily as before, by means of small dots of enamel placed at equal distances on it; but inasmuch as the scales of the different instruments were not formed upon any fixed principle, the results which they furnished did not admit of direct comparison. To obviate this evil, Newton, taking advantage of Hooke's observation, that ice always melted at a fixed temperature, and that, under certain standard circumstances, the boiling-point of water was invariable, proposed the adoption of these as starting-points, between which, and on either side of which, a scale of equal parts should be graduated as required. Though these two points were unanimously agreed upon as the points of reference to be employed, it unfortunately happens that the interval has been subdivided differently in different countries. In Great Britain, Holland, certain of the States of Germany, and North America, the interval between the freezing and the boiling points is divided into 180 equal parts or thermometric degrees. The scale is prolonged by additional equal parts above the boiling and below the freezing points. The zero is placed at the thirty-second division below the latter, so that on this scale the freezing-point is 32° and the boiling-point 212° (32 + 180 = 212). This method of graduation, known as Fahrenheit's, was adopted about 1724. It may be remarked in passing that the reason why the zero was placed at 32° below the freezing-point, was because that point indicated the lowest temperature then known to exist, namely, the most intense cold which had been observed at Iceland. Temperatures very much lower than this, both natural and artificial, have been observed in more recent times.

In France, Sweden, and other parts of Europe, the *centigrade* division introduced by Celsius prevails. In this scale, the interval between the two reference-points is divided into 100°, and the zero is placed at the freezing; temperatures below this being indicated by the prefix of the negative sign.

A system known as Réaumur's is used in Russia and parts of Germany; the interval between the reference-points is divided into 80°. In another scale, formerly used in Russia, and known as De L'Isle's, from its having been invented by that physicist in 1733, the before-mentioned interval was divided into 150° reckoned *backwards* from the boiling-point. Since the number of degrees into which the interval between the freezing and the boiling points in the four systems is divided, are respectively 180, 150, 100, and 80, it follows that

9° Fahrenheit, 7½° De L'Isle, 5° Centigrade, and 4° Réaumur, are severally equal. The conversion of degrees upon one scale into those of another is easily effected by the aid of certain simple formulæ or tables, which will be found in most books treating of the subject. Practically, the conversions which most frequently occur are between Fahrenheit and the centigrade; the former may be regarded as the established scale; the latter the innovating one, pushed forward by the decimal gentlemen, now seeking to indoctrinate the English mind with their hobbies.

It has been found by experiment that mercury when raised from 32° to 212° increases in volume by $\frac{2}{111}$ths of its value at 32°. Thus 111 cubic inches of mercury at 32° will, if raised to a temperature of 212°, become 113 cubic inches. From this may be deduced the increment of volume which mercury receives for each degree of temperature. For since the increase of volume corresponding to an elevation of 180° is $\frac{2}{111}$ths of its volume at 32°, we shall find the increment of volume corresponding to 1° by dividing $\frac{2}{111}$ths by 180, which is $\frac{1}{9990}$. It follows, therefore, that for each degree of temperature by which the mercury is raised it will receive an increment of volume amounting to $\frac{1}{9990}$th of its volume at 32°. It follows also that the weight of the mercury which fills that portion of a thermometer tube representing 1° of temperature will be the $\frac{1}{9990}$th of the total weight contained in the tube. We here assume that equal increments of heat produce equal dilatations of the mercury in the tube, and it has been found by careful experiments that such is actually the case between the freezing and boiling points, but that at extreme temperatures the mercury does not uniformly expand and contract. Since, however, the meteorologist is never called upon to consider extreme temperatures, we may pass over further allusion to this matter.

It may be well here to mention in a summary form the reasons why mercury is so generally adopted for thermometric purposes. It is highly sensitive to changes of temperature, contracting and dilating quickly under the influence of varying temperatures; it freezes at a low and boils at a high temperature, and at temperatures which are not near these extremes, its expansive and contractive powers are very uniform. It does not vapourize and become broken up into small particles in so confined a space, nor does it change its bulk by adhering to the sides of the glass. These are the reasons which have led to its so extensive use. The freezing-point of mercury being −40° and its boiling +600°, a mercurial thermometer will afford correct indications through a very long range of temperatures.

It is not known when and by whom the thermometer was first invented; but in 1590, Sanctorius, of Padua, constructed an air-thermometer. About the middle of the seventeenth century a great improvement was effected by Italian artists, who, under the direction of the members of the *Academia del Cimento*, made spirit-thermometers, as before mentioned.

The idea of using mercury is said to be due to Halley; but, according to Boerhaave, it was Olaüs Römer—known to astronomers as the inventor of the transit instrument, and the discoverer of the motion of light—who first constructed a mercurial thermometer, in 1709. It was, however, Fahrenheit, of Amsterdam, who perfected Römer's invention, by devising the thermometer which now bears his name. M. Breguet, of Paris, has constructed a thermometer founded upon the unequal dilatation of different metals. It is, however, more curious than useful.

The differential thermometer consists of a horizontal glass tube, furnished with bulbs at each end, of the same size, bent twice upwards at right angles. In the horizontal part of the tube a small quantity of coloured liquid is placed. Atmospheric air is contained in the bulbs and tube, but separated into two parts by the column of liquid. The instrument is so adjusted that when the drop of liquid is at the middle of the tube the air in the bulbs has the same pressure; and having equal volumes, the quantities on each side of the liquid are necessarily equal. If the bulbs be affected by different temperatures, the liquid will be forced towards that side on which the temperature is least, and the amount of the departure from the zero or middle of the scale may be ascertained by inspection. The sensitiveness of this instrument is very great, and it is this feature which renders it of great value in delicate physical observations. It being desirable that the liquid should be one which does not give off vapour at ordinary temperatures, diluted sulphuric acid coloured with litmus is usually employed. The differential thermometer was invented by Sturmius, of Altdorf, towards the close of the seventeenth century. Its use was revived by Sir John Leslie and Count Rumford, in 1804. Leslie's construction varies from Rumford's (to which the preceding description specially applies), in having the vertical arms longer than the horizontal one, and in having two scales, one attached to each vertical arm.

It is of great importance in meteorology that the observer should be able to ascertain the highest or lowest point of the thermometric scale, which the column of mercury may have reached during his absence, and several contrivances are in use to obtain a record of this kind.

Notwithstanding that the principles of its construction are not of the most exact kind, the instrument invented by Sixe in 1782, and thence known as Sixe's self-registering thermometer, may be pronounced an exceedingly useful one, perhaps on the whole the best for purely *popular* purposes, in which portability is not an object. It depends for its action on the unequal expansions of mercury and alcohol, and consists of a long glass tube, with bulbs at each end, bent twice in the same direction, and to such an extent that the three sections resulting from the double bending are parallel to each other. Mercury occupies the central portions of the tube, and alcohol the two ends. The tube is mounted vertically, and the mercury is so arranged that it fills those portions of the tube adjacent to the lower bend. From the engraving a general idea of the instrument will be obtained; it is well known, and further description is not requisite. Steel indices slide on each end of the mercurial column.

Another self-registering instrument in general use is Rutherford's. This consists really of two thermometers placed side by side in a horizontal position, one mercurial and the other of spirit. In the former, which registers maximum temperatures, is placed a steel index, which is pushed forward by the mercury when the temperature rises, and remains in that position when the column recedes on the temperature falling. In the latter, which registers minimum temperatures, there is an index of ivory or glass with a flattened end, which recedes with the spirit as it retires in the tube, but which, in consequence of its shape, does not return with the fluid on an increase of temperature taking place, the spirit easily passing by it. It is adjusted to its position at the end of the column of spirit by gently shaking the tube with the bulb end upwards. The chief drawback in this instrument is that occasionally the steel index is found to get clogged by the mercury.

We have now to speak of some single self-registering thermometers.

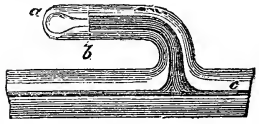
Professor Phillips's for maximum temperatures, is an improvement on Rutherford's. Here a portion of the mercurial column is cut off from the main body by a bubble of air. When the temperature rises, the whole column moves forward; but on falling, that portion beyond the air-bubble remains stationary. The observer can thus at once see the extent of the rise. The instrument is set by a gentle tap.

Negretti and Zambra's maximum self-registering thermo-

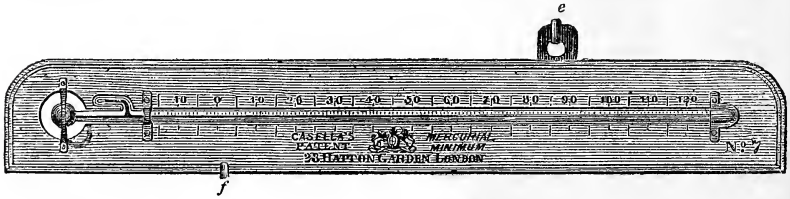
meter also resembles Rutherford's. During the process of construction, a small piece of glass is passed into the tube, which nearly fills the bore: this piece of glass is pushed down nearly to the bulb, and then the tube is bent at that part. When the temperature rises, the mercury is forced past the obstruction; but when the temperature falls, it cannot return, the contraction in the mercury occurring below the bend.* Thus the further end of the detached column shows the limit of maximum rise. When a reading has been taken, the instrument is reset by inclining it, bulb downwards, and giving it a gentle shake.

A good mercurial minimum self-registering thermometer was long a meteorological desideratum; for it is obvious that comparisons of temperatures determined with two such opposite substances as mercury and alcohol could not possibly be entirely satisfactory.

In various experiments conducted by Mr. L. M. Casella for this purpose, it occurred to him that the adhesiveness of mercury for glass in vacuo—together with the fact that where two tubes are united to one bulb, this fluid will rise by expansion in the larger and recede by contraction in the smaller tube—might enable him to obtain the object in view.



The general form and arrangement is shown in the annexed figure. *b* is a tube with a large bore, at the end of which a flat glass diaphragm is formed by the abrupt junction of the small chamber, *a b*, the inlet to which at *b* is larger than the bore of the main tube. The result of this is, that on setting the instrument, the contracting force of the mercury in cooling withdraws the fluid from the main tube only, whilst on its expanding by heat, the long column does not move, the increased bulk of mercury finding an easier passage; namely, into the small pear-shaped chamber attached.



To set the instrument, place it in a horizontal position, with the plate *e* suspended on a nail, and the lower part

* The contraction in the portion cut off is too insignificant to require to be taken into consideration.

supported on a hook, *f*. The bulb end may now be gently raised or lowered, causing the mercury to flow slowly, until the bent part, *b*, is *quite full* and the chamber, *a b*, *quite empty*. At this point the flow of mercury in the main tube is arrested, and indicates the exact temperature of the bulb or air at the time. On an increase of temperature, the mercury will expand, as above explained, into the small chamber, *a b*; and a return of cold will cause its recession from this chamber only until it reaches the diaphragm, *b*. Any further diminution of heat withdraws the mercury from the main tube to whatever degree the cold may attain, where it remains until farther withdrawn by increased cold or till reset for future observation. By this means present temperature may be known, and cold registered to any fraction of a degree, observable on the most sensitive standard thermometer.

There is no separation of the mercury in any of its indications, and no vicissitudes of climate or transit can disarrange the instrument. When out of use, or after a journey, it may be that raising the bulb may not at first cause the mercury to flow from the small chamber as above; in such case, however, a slight tap with the hand on the opposite end with the bulb upwards will readily cause it to do so.

This invention is well spoken of, and promises to be of great value.

Other self-registering thermometers, both for heat and cold, have been invented, but they are not in general use.

The Solar-Radiation Thermometer is a thermometer with a blackened bulb, with a scale divided on the stem, and protected by a glass tube acting as a casing. It is mounted horizontally on two forks resting on the grass, exposed to the full rays of the sun, but sheltered from currents of air.

The Vacuum Solar-Radiation Thermometer differs from the preceding in being entirely enveloped in a glass tube and globe, from which the air has been exhausted. The object of this instrument is to obtain a measure of the amount of the solar radiation freed from the casual effects of passing currents of air. Observations in different localities, or in the same locality under different circumstances, are thus comparable with each other, which is not the case when they are made with exposed instruments.

The Terrestrial Radiation Thermometer resembles the solar instrument, except that the bulb is not blackened.

So much for thermometers as regards their general constructions and different forms. Much more might be said in reference to them, but the space at our disposal necessitates a limitation.

Dr. Miller, of King's College, than whom no one is better entitled to be heard on matters of this kind, gives the following as tests which a good thermometer should answer:—"When immersed in melting ice, the column of mercury should indicate exactly 32° F.; when suspended with its scale immersed in the steam of water boiling in a metal vessel (the barometer standing at thirty inches), the mercury should remain stationary at 212°. When the instrument is inverted, the mercury should fill the tube and fall with a metallic click, thus showing the perfect exclusion of air. The value of the degrees throughout the tube should be uniform. To ascertain this, a little cylinder of mercury may be detached from the column by a slight jerk, and on inclining the tube, it may be made to pass from one portion of the bore to another. If the scale be properly graduated, the column will occupy an equal number of degrees in all parts of the tube."

Not one thermometer in fifty of those commonly sold in the shops will stand these simple and (if accuracy is really to be thought of) indispensable tests. In numerous shop-windows stacks of thermometers may be seen, which though all in close proximity, indicate the most discordant results instead of perfect harmony or even respectable uniformity. Dr. Miller adds the following cautionary remarks:—"If a thermometer be graduated immediately after it has been sealed, it is liable to undergo a slight alteration in the fixed points of the scale, owing to the gradual contraction of the bulb, which does not attain its permanent dimensions until after the lapse of several months. This contraction is probably due to the pressure of the atmosphere. From this circumstance the freezing-point may become elevated from $\frac{1}{4}$ to $\frac{1}{2}$ a degree; and thus the graduations throughout the scale indicate a temperature which is higher than the true one by the amount of the error. In some thermometers the bulb, as Pierre has shown, does not at once contract to its proper dimensions; and thus a temporary displacement of the graduation is caused every time such instruments are heated to 212°." Regnault has found that some mercurial thermometers which agree in this indication at the freezing and boiling points, differ at intermediate positions; and that these differences frequently amount to several degrees, a circumstance which the observer in question thinks may be due to the unequal expansion of different kinds of glass. Enough has been said to show the delicacy of these instruments, and it must be quite obvious that at such a price as one, two, or three shillings, it is impossible to manufacture an instrument with any solid claims to reliability. Instruments of this character will indicate relative changes, but absolute values of *value* can only be obtained from carefully made (*i. e.* expen-

sive) ones; and thus it is infinitely better for an intending meteorological observer of limited means to concentrate his funds on the acquisition of one or two really good instruments, than seek to obtain an imposing show of worthless ones, always supposing that he desires to work for the benefit of science;—but we are digressing.

Pyrometer is the name applied to certain forms of heat-measurers designed to register extreme temperatures, rising to hundreds or thousands of degrees, heat which, as the name imports, is only met with in fires and furnaces. A good pyrometer is still a desideratum; and as, besides this, they are only required for use in factories and for processes in the arts, no good purpose would be served by entering into any remarks on them in a popular article like the present.

ON THE ABSORPTION AND RADIATION OF HEAT.

BY H. DEBUS, PH.D., F.R.S.

ON the absorbing energy of aqueous vapour, and its influence on terrestrial radiation, we quote Professor Tyndall's own words :—

When we speak of radiation through the atmosphere, we ought to be able to affix definite physical ideas, both to the term atmosphere and the term radiation. It is well known that our atmosphere is mainly composed of the two elements, oxygen and nitrogen. These elementary atoms may be figured as small spheres scattered thickly in the space which immediately surrounds the earth. They constitute about 99½ per cent. of the atmosphere. Mixed with these atoms, we have others of a totally different character ; we have the molecules, or atomic groups, of carbonic acid, of ammonia, and of aqueous vapour. In these substances divers atoms have coalesced to form little systems of atoms. The molecule of aqueous vapour, for example, consists of two atoms of hydrogen united to one of oxygen ; and they mingle as little triads among the monads of oxygen and nitrogen, which constitute the great mass of the atmosphere. These atoms and molecules are separate ; but in what sense ? They are separate from each other in the sense in which the individual fishes of a shoal are separate. The shoal of fish is embraced by a common medium, which connects the different members of the shoal, and renders intercommunication between them possible. A medium also embraces our atoms ; within our atmosphere exists a second and a finer atmosphere, in which the atoms of oxygen and nitrogen hang like suspended grains. This finer atmosphere unites not only atom with atom, but star with star ; and the light of all suns and of all stars is, in reality, a kind of music propagated through this interstellar air. This image must be clearly seized, and then we have to advance a step. We must not only figure our atoms suspended in this medium, but we must figure them vibrating in it. In this motion of the atoms consists what we call their heat. "What is heat in us," as Locke has perfectly expressed it, "is in the body heating nothing but motion." Well, we must figure this motion communicated to the medium in which the atoms swing, and sent in ripples through it with inconceivable velocity through space. Motion in this form, unconnected with ordinary matter, but speeding through the interstellar medium, receives the name of radiant heat, and, if competent to excite the nerves of vision, we call it light.

The waves of heat speed from our earth through our atmosphere towards space. These waves dash in their passage against the atoms of oxygen and nitrogen, and against the

molecules of aqueous vapour. Thinly scattered as these latter are, we might naturally think meanly of them as barriers to the waves of heat. We might imagine that the wide spaces between the vapour molecules would be an open door for the passage of the undulations, and that, if those waves were at all intercepted, it would be by the substances which form 99½ per cent. of the whole atmosphere. Three or four years ago, however, it was found that this small modicum of aqueous vapour intercepted fifteen times the quantity of heat stopped by the whole of the air in which it was diffused. It was afterwards found that the dry air then experimented with was not perfectly pure, and that the purer the air became, the more it approached the character of a vacuum, and the greater, by comparison, became the action of the aqueous vapour. The vapour was found to act with 30, 40, 50, 60, 70 times the energy of the air in which it was diffused, and no doubt was entertained that the aqueous vapour of the air which filled the Royal Institution theatre absorbed 90 or 100 times the quantity of radiant heat which was absorbed by the main body of the air of the room.

Looking at the single atoms, for every 200 of oxygen and nitrogen there is about 1 of aqueous vapour. This 1, then, is 80 times more powerful than the 200; and hence, comparing a single atom of oxygen or nitrogen with a single molecule of aqueous vapour, we may infer that the action of the latter is 16,000 times that of the former. It is perfectly certain that more than 10 per cent. of the terrestrial radiation from the soil of England is stopped within ten feet of the surface of the soil. This one fact is sufficient to show the immense influence which this newly-discovered property of aqueous vapour must exert on the phenomena of meteorology.

This aqueous vapour is a blanket more necessary to the vegetable life of England than clothing is to men. Remove for a single summer night the aqueous vapour from the air which overspreads this country, and you would assuredly destroy every plant capable of being destroyed by a freezing temperature. The warmth of our fields and gardens would pour itself unrequited into space, and the sun would rise upon an island held fast in the iron grip of frost. The aqueous vapour constitutes a local dam, by which the temperature of the earth's surface is deepened; the dam, however, finally overflows, and we give to space all that we receive from the sun.

The sun raises the vapours of the equatorial ocean; they rise, but for a time a vapour-screen spreads above and around them. But the higher they rise the more they come into the presence of pure space, and when, by their levity, they have

penetrated the vapour-screen, which lies close to the earth's surface, what must occur?

It has been said that, compared atom for atom, the absorption of an atom of aqueous vapour is 16,000 times that of air. Now, the power to absorb and the power to radiate are perfectly reciprocal and proportional. The atoms of aqueous vapour will therefore radiate with 16,000 times the energy of an atom of air. Imagine, then, this powerful radiant in the presence of space, and with no screen above it to check its radiation. Into space it pours its heat, chills itself, condenses, and the tropical torrents are the consequence. The expansion of the air, no doubt, also refrigerates it; but, in accounting for those deluges, the chilling of the vapour by its own radiation must play a most important part. The rain quits the ocean as vapour, it returns to it as water. How are the fast stores of heat, set free by the change from the vaporous to the liquid condition, disposed of? Doubtless, in great part, they are wasted by radiation into space. Similar remarks apply to the cumuli of our latitudes. The warmed air, charged with vapour, rises in columns, so as to penetrate the vapour-screen which hugs the earth; in the presence of space, the head of each pillar wastes its heat by radiation, condenses to a cumulus, which constitutes the visible capital of an invisible column of saturated air.

Numberless other meteorological phenomena receive their solution by reference to the radiant and absorbent properties of aqueous vapours. It is the absence of this screen, and the consequent copious waste of heat, that causes mountains to be so much chilled when the sun is withdrawn. Its absence in Central Asia renders the winter there almost unendurable. In Sahara, the dryness of the air is sometimes such, that though, during the day, "the soil is fire, and the wind is flame," the chill at night is painful to bear. In Australia, also, the thermometric range is enormous, on account of the absence of this qualifying agent. A clear day and a dry day, moreover, are very different things. The atmosphere may possess great visual clearness whilst it is charged with aqueous vapour, and on such occasions great chilling cannot occur by terrestrial radiation. Sir John Leslie and others have been perplexed by the varying indications of their instruments on days equally bright, but all these anomalies are completely accounted for by reference to this newly-discovered property of transparent aqueous vapour. Its presence would check the earth's loss; its absence, without sensibly altering the transparency of the air, would open wide a door for the escape of the earth's heat into infinitude.

REVIEWS.

ANTI-DARWINIANISM.*

IT very seldom happens in any controversy, that, when a partisan of either side comes to speak, he states something which is satisfactory to both parties. We should not have expected such a result in the case of the debate—not yet extinguished—between the supporters of Mr. Darwin's doctrines and those who oppose them. Yet such has actually occurred. M. Flourens, one of the oldest and most renowned of French physiologists, has written a work which he calls an "Examination" of that treatise, which is now classic,—"The Origin of Species;" and in it we observe a production which will be hailed with pleasure by both "Creationists" and "Selectionists." Such, however, is far from what the author intended. The book is written in the most bitter spirit, and is totally devoid of that dispassionate consideration of evidence which should ever be the aim of the philosopher. M. Flourens has damaged his own case very seriously, and while his party may rejoice that a volume of abuse has been hurled against Darwinian speculations, the opposite side may congratulate itself that so little has been done to impugn its views, and so much has been effected to deteriorate its opponents' case.

Of the hundred and seventy pages which M. Flourens' book contains, but seventy are devoted to a critique of Mr. Darwin's essay, the remainder being absorbed by a loose collection of irrelevant matters; thus we find the following among the headings of the succeeding chapters:—Decaisne's Experiments on the Variability of Species; Swammerdam, Réaumur, and others on the Generation of Insects; Van Beneden on Parasitic Worms; and Pasteur on Spontaneous Generation. The author harps on the old string, the non-fecundity of genera, and omits to notice the grander portion of the Darwinian theory. He speaks of species as things defined, and yet the only definition he gives is that which relates to fecundity. Forgetting that species is a purely abstract term, he confounds it with animal form, and thus he shows at the very outset an utter inability to appreciate even the fundamental principle of the doctrine of "natural selection." M. Flourens' argument is this: a new species cannot originate by natural selection, because certain animals are not fertile when brought together. If new species were merely variations of one which had pre-existed, then they should be fertile among each other. We reply, we know not what a *species* is, unless

* Examen du Livre de M. Darwin sur "l'Origine des Espèces." Par P. Flourens, Professeur au Muséum d'Histoire Naturelle, &c. &c. Paris: Garnier frères. 1864.

it be one of those terms which have in every age trammelled the progress of philosophy; therefore we request that a species be defined by our opponent. We have shown that new animal *forms*, differing as much from each other as recognized species do, have been called into existence by natural and artificial selection, and that is a great step towards the solution of the mystery. It is true that these forms are capable of combining genetically, but may we not suppose that the varieties, most unlike, may, in course of ages, and after subjection to different external conditions, be so altered, physiologically as well as morphologically, that their capability of fertile inter-communication shall diminish or cease? A chemical element is to a certain extent analogous to a species; it possesses its own intrinsic properties, yet if it be submitted to new conditions, it will be so materially altered that it will possess several new properties, and will have lost some of its former ones. Take phosphorus for example; what can be more remarkable than the power which the red allotropic variety possesses of forming compounds with sulphur, which the other kind is devoid of? We might give similar illustrations *ad infinitum*. One thing is significant; species can have originated in but one of two ways—creation and natural selection. A few traditions are evoked in support of the former method; a thousand arguments from analogy support the latter. We do not say Mr. Darwin's doctrine is unquestionably the right one, but we do maintain that it is the one most in accordance with recognized facts, and that also which appeals above all to our reasoning faculties.

M. Flourens' book will afford a certain amount of satisfaction to the disciples of the old school, but it will be read by Darwinians with intense amusement.

FORCE AND MATTER.*

IF the reader were to take up this volume in expectation of finding a disquisition upon those beautiful laws enunciated by Grove, Tyndall, and others, he would be sadly disappointed. The title does not express correctly the nature of the work. Dr. Büchner's treatise, though dealing indirectly with the results of modern scientific research, is incontestably a work on Atheism. In every page we find a slashing attack on the Deistic creed, and though in many instances the author has conducted his side of the controversy with becoming impartiality, in others he has set no bound to his opinions, and the expression of his views is characterized by a low style of language, which certainly borders on the grossest form of blasphemy. Considered apart from these features, the work is an interesting one, and may be read with advantage by those who are not easily led away by a subtle sophistry. The first object of the writer is to show that matter is indestructible, and this he achieves with tolerable success; but when he

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* "Force and Matter; Empirico-Philosophical Studies intelligibly rendered." By Dr. Louis Buchner. Edited from the last edition of "Kraft und Stoff." By J. F. Collingwood, F.R.S.L., &c. London: Trübner & Co. 1864.

approaches his second aim, we think he loses himself in a muddle of metaphysics. In trying to prove that force has always existed, we find he has placed the reader in the same position with regard to himself, as that alluded to in the Scotchman's definition of the science of mind,—for assuredly "he dinna ken exactly what he means," and his reader "doesn't understand him." In this respect we think Dr. Büchner has gone a step too far. So long as he exerts his reasoning powers, we shall be anxious to listen to him, but when he travels beyond his proper sphere, and asserts that because "all the planets of our system are not so formed as to be inhabited by man," there is therefore no God, we shall most unquestionably refuse to argue with him. In making such an assertion he passes from what he can comprehend to what he cannot, and thus his whole argument is founded on a *petitio principii*.

BRITISH CONCHOLOGY.*

WHEN noticing the first volume of Mr. Jeffreys' work, we had occasion to speak in very complimentary terms of its character as a text-book for the student and a readable companion for the amateur. The second volume is now before us, and we observe nothing in it calculated to alter the opinion we before expressed. That portion of the "British Conchology" which deals with marine shells, is as well executed as the rest, and contains, besides a most interesting "introduction," the Zoology of the Brachiopoda, and of the Lamelli branchiata from the family of the Anomias to that of the Mactras. The author's style is peculiarly felicitous, and is attractive even to those who know nothing whatever of natural science. It must not be supposed, on that account, that accuracy has been made subservient to popularity; far from it; we observe, on the contrary, that the most recent researches find a notice, and that on certain points where doubt is justifiable, a fair proportion of scepticism is exhibited. Selecting the genus Ostræa as a type of what Mr. Jeffreys has done for our British shells, we perceive, first, a description of the genus, then a list of the specific synonyms and description of the species, which is of considerable length; next follow the several varieties, and finally we arrive at the natural history of the mollusk. This is the pleasantest reading of all; there are nine pages of letter-press devoted to the habits, distribution, structure, commercial bearings, culture, and history of the oyster, and these our readers should certainly make themselves familiar with. If we were to be exceedingly critical, we should say that the geographical distribution is not as amply given as it might have been, but in other respects the book is a most valuable one, and possesses in combination a greater number of good qualities than we usually find united in treatises of its class.

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* "British Conchology; or, an Account of the Mollusca which now inhabit the British Isles and the surrounding Seas." Vol. II. Marine Shells. By J. Gwin Jeffreys, F.R.S., F.G.S., &c. London: Van Voorst. 1863.

COMPANIONS TO THE MICROSCOPE.*

EVERY working microscopist knows the Micrographic Dictionary, and is therefore familiar with Dr. Griffith's name. It will consequently delight him to learn—especially if he belongs to the amateur rather than the professional class—that a treatise on the use of the microscope has been written by the joint author of our most valuable encyclopædia of histology. The student must not expect to find in this essay, information regarding the preparation of objects; but though in this respect the production is imperfect, it is in other respects extremely well executed. The author treats rather of the structure of vegetable and animal tissues (especially the former), when seen under the microscope. This he has done, we think, with great success. Intercalated with the text are twelve page plates, on which are grouped nearly 400 coloured illustrations, which, if too highly tinted in some cases, are at least tolerably faithful representations, and have their natural dimensions indicated by affixed numbers showing the magnifying power employed. The latter we regard as a decidedly commendable feature of Dr. Griffith's text-book, and one which we hope to see more extensively adopted in popular works. The descriptions in the text are remarkably lucid, and cannot fail to convey accurate notions of the form and relations of minute parts. We entirely approve of the author's plan for teaching the reader the correct pronunciation of technical terms. Long Latin names which have hitherto puzzled many a beginner, will under Dr. Griffith's system be read as easily as English ones. The last chapter is devoted to the consideration of the optical principles involved in the construction and use of the microscope; and here the subject is handled in such a clear and yet masterly manner, that few can read it without much profitable instruction.

Forming a marked contrast to the text-book we have just noticed, is the little manual of Mr. Davies. The former is a work upon the structure of the tissues, the latter is almost exclusively devoted to the methods to be employed in preparing various objects for microscopic inspection. Students, amateurs, and men of science alike, are frequently ignorant as to the best mode of mounting an object in order to exhibit its structure to advantage. Do they require to prepare a slide, "put up" an insect, inject vessels, or make a section, this is the only work where they can obtain every information as to the means they should adopt. Most copious are the details given by the author of the little volume which lies upon our table. It is the book of books for microscopists. Every chapter is complete in itself, and is an exhaustive essay on the subjects it deals with. The descriptions of the several forms of cement are given at length, and the respective merits of Canada balsam, asphaltum, marine glue, gold size, liquid glue, black japan, gum-water, and black and sealing-wax varnish, are described in such a manner

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* "An Elementary Text-Book of the Microscope," &c. By J. W. GRIFFITH, M.D., F.L.S., &c. London: Van Voorst. 1864.
"The Preparation and Mounting of Microscopic Objects." By THOMAS DAVIES. London: Robert Hardwicke. 1864.

as to show that the writer is not merely a compiler, but honestly states the results of his experience. The paragraphs devoted to the mammalian tissues are rather imperfect; but this is a defect which, though disappointing to the human anatomist, will be readily forgiven by most of our readers. In the chapter on injections nothing has been left undone to aid the student in carrying out his operations successfully, and the claims of all our professional microscopists have been candidly acknowledged. We wish we had space enough at our command to give a series of extracts from Mr. Davies's book, which certainly cannot be adequately reviewed within our limits. It is one of those works which can be read unsystematically, for every page abounds in profitable information complete in itself. It is a treatise which should be on the table of every microscopist, and we can conscientiously say it is the best *vade-mecum* we have ever seen.

THE STREAM OF LIFE.*

A LARGE book and withal a well-written one. Such is Mr. Milton's production. To say that the title hardly expresses the nature of the matter found within the covers, would be only to repeat what we have to express in regard to hundreds of similar effusions. The author opens the flood-gate at about the middle of the Cambrian period, allows the vital current to flow gently on through pre-Mosaic and historic times, and then by a singular application of the laws of hydro-dynamics supposes it to wend its way to worlds beyond our ken, where he modestly leaves it. The book may be said to be really a series of popular essays on different branches of science. Thus we find that geology, archæology, philology, natural history, physiology, and astronomy, have successively engaged Mr. Milton's attention. To criticise a work like the present would hardly be fair; "Crichtons" are rare in this century, and we do not think that our author is one of them. He has written a volume of popularized science, which will be read with interest by most people, not only because of the curious information it contains, but for the simple reason that the style is characterized by a graceful, easy diction, and by an absence of those inelegances which too often deface the pages of scientific treatises. The attack on Mr. Darwin's doctrines has been very clumsily made, and on that account, and from the fact that Mr. Milton evidently neither understands the subject nor has given it consideration, we will not be severe upon him. His physiology, likewise, is occasionally at fault. On the whole, the book is as free from errors as any other compilation of a similar class, and though some believe that works which convey a little inaccurate with a great deal of accurate information are nevertheless pernicious, we do not subscribe to the dogma. Hoping to meet Mr. Milton again, we commend him to Professor Huxley's care for the present, and we beg to assure our friends that they will travel over the pages of his volume both profitably and agreeably.

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* "The Stream of Life on our Globe: its Archives, Traditions, and Laws, as revealed by Modern Discoveries in Geology and Palæontology," &c. By J. L. Milton, M.R.C.S. London: Hardwicke. 1864.

ELEMENTARY BOTANY.*

FEW if any of our savans possessed the power of imparting knowledge in such a simple yet lucid manner as the late Professor Henslow. Those of his pupils who were educated at the parish school of Hitcham, can bear ample testimony to the accuracy of this assertion. It is, therefore, with considerable pleasure that we find so distinguished a botanist as Professor Olliver has written an elementary manual, based in part upon the manuscript material left by the late professor. The physiological portion of this little book has been written by Mr. Olliver, and fully realizes all our anticipations. It is rigidly accurate, and yet the style has a charm about it not often met with in botanical works. The manner is most fascinating, and if it does not succeed in making this division of science interesting to every one, we do not think anything can. The arrangement of the several organs which enter into the composition of a flower is nicely given, and the explanation of the distinction between Thalamifloræ and Calycifloræ, as illustrated by the buttercup and bramble, is tersely stated. In the chapter on stems we do not find the terms endogenous and exogenous, and we are glad of it; they never definitely expressed the relation of the vascular bundles to the other parts. The fibro-vascular bundles of a dicotyledon and monocotyledon are compared side by side, and the reader is taught as much about the structure of stems in this way, as if a far more lengthy description than that accompanying them had been given. The chapter on the classification of plants is philosophic without being heavy, and that on cells and fibres is equally good. In the systematic portion, the more typical natural orders are described at some length, and the application of Professor Henslow's scheme (described in the last number of POPULAR SCIENCE REVIEW) is explained. Nearly two-hundred well-executed woodcuts are scattered through the text, and a valuable and copious index completes a volume which we cannot praise too highly, and which we trust all our botanical readers, young and old, will possess themselves of.

THE FLORA OF ULSTER.†

ABOUT thirty years ago, when the British Association met in Cork, several communications were made regarding the distribution of plants in the neighbourhood. The matter thus supplied was afterwards put forward in the form of a volume on the Flora of the country. This was, as far as we can recollect, the only local Flora compiled in Ireland till the appearance of the present one, which has been issued under the superin-

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* "Lessons in Elementary Botany. The part on Systematic Botany based upon Materials left in Manuscript by the late Professor Henslow." By DANIEL OLLIVER, F.R.S., F.L.S., Professor of Botany in University College. London and Cambridge: Macmillan. 1864.

† "The Flora of Ulster, and Botanist's Guide to the North of Ireland." By G. DICKIE, M.A., M.D., F.L.S. Belfast: Aitchison. London: Lovell Reeve. 1864.

tendence of the Professor of Botany in the University of Aberdeen. Dr. Dickie resided for many years in the north of Ireland during his tenure of the chair of Natural History in the Belfast Queen's College. Hence he is no mean authority upon the subject of the Ulster Flora. This book is quite a model of its sort, and as it is in a great measure founded in principle on Watson's "Cybele Britannica," our readers can fancy for themselves the character of the information it contains. Not only is the geographical distribution of each plant given, but where it has been possible, the vertical (bathymetrical) range has also been stated. Special attention is called to the nature of the soil, and in some instances we find that even a thermometrical examination has been made. The index of genera is a good one, and the supplementary list of plants "possibly introduced" shows that the writer is above those vulgar prejudices which lead local botanists into the cataloguing of species, which their reason should tell them are by no means indigenous. In the Introduction we are treated to a general sketch of the geological features of the province, and also to some considerations concerning the meteorologic conditions under which plants exist. Special notices have been given of the vegetation of some of the mountains, and altogether the "Flora of Ulster" may be said to reflect credit on its compiler.

GEOLOGICAL ESSAYS.*

THE author of the book which bears the above title has given us a pleasant production, though it is one in some measure of the *fricassée* stamp. He writes nicely, and being in addition possessed of some considerable general geological knowledge and literary culture, he has produced an agreeably popularized medley of local strata and fossils, non-original speculations, and a large proportion of Pope, Shakespeare, Tennyson, Addison, &c. We find no fault with works of this kind, and we are certain that publishers are like unto us in this regard, so long as the volume is printed—as we have no doubt the present one was—at the author's expense. We cordially agree with Mr. Taylor when he asserts that during the long period occupied by the processes of denudation, even "the wisest of us cannot tell" what took place, and that consequently many of our connecting links may have been lost during that epoch. And although we perceive that he has drawn rather extensively, upon the works of living writers, we do not think him highly reprehensible for that. There is no crime nowadays in literary larceny. We conceive, however, that Mr. Taylor need not have brought in Scripture to his aid so frequently; it seems to us that the frequent introduction of passages from the Bible looks very like affectation, and however good the writer's intentions may have been, it would have been better and wiser to

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* "Geological Essays and Sketch of the Geology of Manchester and the Neighbourhood." By JOHN TAYLOR, Member of the Council of the Manchester Geological Society. London: Simpkin & Marshall. 1864.

have exhibited a little more restraint. Ill-natured folk are still to be found in the world, and there are many who would be quite malicious enough to insinuate that the peculiarity we allude to was merely cant. If divested of this feature, Mr. Taylor's work can be read with both pleasure and profit, and we wish it all the success it is entitled to.

SAXBY'S WEATHER SYSTEM.*

VIEWING the question from a purely meteorological aspect, we think Mr. Saxby's opinions are deserving of some consideration. He advances a doctrine which is "as old as the hills," and supports it to a certain extent by scientific evidence. The lunar theory is Mr. Saxby's favourite. We believe it to be a hypothesis to which few meteorologists pin their faith; but there can be little doubt that it is one much affected by that weather-wise portion of the community—the oldest inhabitants. That the moon does influence the weather, we think there are many who will agree with Mr. Saxby in admitting; and though we have not been convinced by the weight of his arguments or the subtlety of logic, we think, as we have said already, that his ideas merit an examination. It is not at all unlikely that any opposition which this gentleman has experienced at the hands of men of science has been due to the somewhat "sledge-hammer" mode he has of conveying his views. Moreover, there is an exquisitely delicate tinge of self-conceit about the style in which he trumpets his own discoveries (?) that is not in our opinion at all calculated to forward his aims. Nothing is more repulsive to the rational mind than the constant adoption of the "Ego et Rex meus" principle. It is one thing to employ a method of this kind with friends, who, in seeing other good qualities, forgive the egotism; but an author should remember that he is only known to the public through his writing. Readers will not care to learn that Mr. Saxby touches "*the subject with clean hands,*" and is "*indebted to no mortal for the observations which have led to his discovery of a lunar influence on the weather.*" Should the author profit by our advice, we shall be very happy to say a good word for him on some future occasion.

SCIENTIFIC AGRICULTURE.†

PROFESSOR JOHNSTON'S treatise has been long and favourably known to the agricultural students of this country, and we do not think we err in supposing that the present edition will meet with the same success as the former ones. It is just the book which may be employed

* "Saxby's Weather System, or Lunar Influence on the Weather." By S. M. Saxby, Esq., R.N., &c. &c. Second Edition. London: Longman & Co. 1864.

† "Elements of Agricultural Chemistry and Geology." By James F. W. Johnston, M.A., &c. Eighth Edition. London: Blackwood & Sons. 1863.

"Scientific Farming made Easy; or, the Science of Agriculture reduced to Practice." By Thomas C. Fletcher. London: Routledge & Co. 1864.

by the student, while in attendance on a course of agricultural lectures. The subjects of chemistry, geology, and botany, of which agricultural science may be said to be compounded, find a place in this volume. Moreover, the explanations are not couched in over-technical language, an advantage which most persons will gladly avail themselves of. The book professes to be an *exposé* of the elements of the science, and it fulfils its title fairly; there is, however, one serious objection to it, and that is, Liebig's views are not represented. Mr. Johnston speaks of the operation of manures containing ammonia in large quantities as being beneficial to the soil. This is not correct; the opposite is the truth. The only action of ammonia as a manure is to dissolve the more purely mineral constituents of the soil, and by thus supplying them in larger proportion to the plant, to rob the former of its most valuable properties. Again, as the researches of Schoenbein have recently proved, the mere evaporation of the water from the surface of the earth gives rise to enormous quantities of nitrites, and consequently to nitrates of *ammonia*. Farmers need only supply the inorganic ingredients of plants,—the rest will be furnished by the atmosphere. This is the *sheet-anchor* maxim of Saxon and scientific agriculturists.

We certainly cannot speak in any but terms of disapprobation of Mr. Fletcher's *brochure*, which we regard as one of those mischievous productions calculated to suppress scientific inquiry, by wholesale assertions unsupported by the faintest shadow of evidence. Mr. Fletcher may be an analytical chemist, but he is certainly a bad reasoner, and a much worse physiologist. We should advise him to peruse Liebig's last work, "The Natural Laws of Husbandry," and also M. Blanchet's letters to the *Gazette de Lausanne* of last December. Trusting that their influence may engender in him a more philosophic frame of mind, we bid him *addio*.

AUSTRALASIAN CLIMATES AND PULMONARY CONSUMPTION.*

THE consumptive patient is frequently advised to travel. The doctor advises a tour to Algeria, or the Pyrenees, or some such locality. It is not often, however, that we find Australia is the place selected. There appears, notwithstanding, to be much reason in support of the opinion, that the climates of our antipodes are calculated to arrest the progress of scrofulous diseases; this, at least, appears to be the result of the experience of Dr. Bird, the author of the above-named treatise. Dr. Bird himself is one who, having been attacked by phthisis, left England for Melbourne, and after a comparatively short residence in the latter city, observed the gradual disappearance of his consumptive symptoms. Hence his essay will be read with anxious interest by all invalids who fancy themselves labouring under the scrofulous diathesis. *En passant*, we may

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* "On Australasian Climates and their Influence in the Prevention and Arrest of Pulmonary Consumption." By S. Dougan Bird, M.D., &c. London: Longman & Co. 1863.

remark that the work before us appeals to the general reader rather than to the medical man. It is not on this account inaccurate; on the contrary, apart from any considerations as to the correctness of the writer's notions concerning the climatic influence of Australia, those parts regarding the pathology of the disease and the mode of treatment are quite in accordance with the most advanced views of the present day. Dr. Bird does not suppose (as most non-professional folk do) that consumption is a disease of the lungs; he admits that it is a generally diseased condition of the blood (arising possibly from primary derangements of the digestive system), which may exhibit itself in any portion of the frame, but appears most commonly in the lungs. In addition to the method of treatment ordinarily adopted, he strongly urges the employment of the seton, as a means of counter-irritation, having found in many cases that, when used in the neighbourhood of a cavity, it produced a considerable improvement of that portion of the lung. Time alone can decide whether Dr. Bird's views as to the influence of the Australian climate are correct, but in the meantime his book will afford satisfaction to thousands.

THE BIRDS OF INDIA.*

OUR ornithological readers, who are doubtless familiar with the first volume of this work, will be glad to learn that the second has appeared. It is somewhat disappointing to find that the present volume is not complete, having been, unlike the former one, published in two parts, of which the first has alone reached us. The author apologizes for this peculiarity, by stating that the time required in compiling a careful index induced him to publish the portion that was ready for press, rather than wait till the volume was complete. He also remarks that, by thus bringing out the book in two issues, he will be put to considerable expense. We accept his statements, though we do not exactly see why the index need require such careful compilation as he seems to imply. The text of the present portion of Vol. II. embraces a continuation of the natural history of the Insessores, including the families *Merulidæ*, *Brachypodidæ*, *Sylviadæ*, and *Ampelidæ*, and also of the conirostral families, the *crows*, *starlings*, and *finches*. The generic and specific descriptions are, with a few exceptions, clearly stated; but we do not think the lists of synonyms are as copious as they ought to be, for the purposes of comparison and identification of species. Another drawback is the entire absence of illustrations, which renders it necessary that the text should be as explicit as possible. We cannot say much in favour of the printers: the book is, in a mechanical point of view, got up rather roughly.

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* "The Birds of India; being a Natural History of all the Birds known to Inhabit Continental India, with Descriptions of the Species, &c." By T. C. JERDON, Surgeon-Major Madras Army. Calcutta: printed by the Military Orphan Press. 1863.

NATURE AND THE GENETIC RECORD.*

IT often happens that when men of shallow minds have pursued some special branch of study for a great number of years they become veritable monomaniacs, and so far from having expanded their mental faculties, they have so contracted them that what they understood in the beginning they find a perfect mystery toward the close of their careers. Our novelists have not been remiss in pointing out this tendency to mental degeneration, and we have Mr. Scattergood and the venerable parent of Mr. Midshipman Easy as memorable instances of this cerebral derangement. We have been led to express the above opinion from a careful perusal of the work before us. *Imprimis*, be it understood we do not for a moment desire it to be supposed that we think the author *non compos mentis*. Of him personally we are as ignorant as of that individual supposed to take up his abode in our nearest planet. But we must frankly declare that after reading his book through from cover to cover, we consider it to be the wildest specimen of sane composition ever yet produced. What the aim of the book is we know not. The drift of it we find a similar difficulty in discovering. That we may not be accused of prejudice, we now submit a few quotations to the notice of our readers :—

"*Sono-magneto-electricity shows us the how and why of absorbent or non-cohesive static relations attaining to the undulant requirements of sound, and to the reflectant repulsive energy of rigidly constricted silence.*" . . . "*In the vegetable, spiral power or heat is the predominant ; therefore there is ever a oneness of crystalline axis or tendency thereto.*" . . . "*Superior to all the work which man can do, is the simple act of belief in so far as it relates to himself in particular, because it appears to be a free will, act and offering, because it evades the selfish mono-central force of death-rigidity, whilst it harmonizes a composite aggregation capable of sentient exercise throughout all eternity.*"

It surprises us to see Messrs. Longman's names upon the title-page of this extraordinary effusion.

HOMES WITHOUT HANDS.†

MR. WOOD is clearly not tired of compiling popular natural history works. Here we have a new one coming out in monthly parts. The subject is more original than those usually selected by this popular writer, and from the style in which the work is being executed by the publisher, we have little doubt of its success. Parts I. and II. include a description of the habits of the various burrowing mammalia, such for example as the *mole, Arctic fox, weasel, white bear, porcupine ant-eater,*

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* "Natural Phenomena : The Genetic Record and the Sciences harmoniously arranged and compared." By Alexander McDonald. London : Longman & Co. 1863.

† "Homes without Hands." By the Rev. J. G. Wood, M.A., F.L.S. London : Longman & Co. 1864. Parts I. and II.

ornithorynchus, &c.; and also touch on the burrowing birds—as the *sand-martin*, *kingfisher*, and *puffin*. These descriptions are given in Mr. Wood's familiar and seductive manner, and contain a species of information absent from most of our popular treatises. We must, however, caution the author against confounding two such birds as *Fratercula arctica* and *Puffinus brevicaudus*. Parts III., IV., and V. conclude the account of the homes of birds, and narrate how the land-crabs, shrimps, pholades, shipworms, scorpions, spiders, ants, bees, wasps, beetles, and crickets construct their domiciles; and in most instances the natural history is faultless. The numbers before us are profusely illustrated, and the illustrations are exquisitely done and very attractive. We hope the future numbers will not be found wanting in these important features, and heartily wish the new work every success.

THE ENTOMOLOGIST'S ANNUAL.*

THIS little publication is full of matter interesting to all insect hunters. The opening article on "Travel," by Mr. Stainton, the well-known Secretary to the Ray Society, is cleverly written, and is succeeded by a translation from the Entomological Journal of Stettin, describing a journey made to Finmark by Dr. Wocke. This is not confined to descriptions of insects, but contains a pleasing sketch of the contour of the country travelled over, the character of the inhabitants, &c. The third article is a long one, "On the new Species of Coleoptera discovered during the past year;" then comes an extract from Bates's "Naturalist on the Amazons." The remaining papers are on "Hymenoptera," and "On new and rare Species of Lepidoptera."

Evening Thoughts, by a Physician (Van Voorst, 1864), is a book which is certainly calculated to do good by developing the metaphysical powers in connection with the nobler emotions of the mind. To the person who reflects, this volume will be of service; to the unthinking, even, it can do no harm. While we admit that in many instances, the writer's conclusions are assumed, we cannot help admiring the tendency of his opinions.

The Study of the Physical Sciences. By GEORGE WOOD. (Calder, 1864). The author of this little brochure is evidently a man of some culture. He advocates the study of Physical Science, and does so with considerable force. We dissent from some of his opinions, but think his essay will be read with advantage by those connected with our large educational institutions.

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* "The Entomologist's Annual for 1864." London: Van Voorst.

The Dictionary of Medical and Surgical Knowledge (Houlston & Wright, 1864), is not, as its name would indicate, a ponderous tome under which "professional" shelves would groan. It is an unpretending-looking work, intended for the use of households, emigrants, *et hoc genus omne*. We have seen only the first volume, but from what we have observed we think it by no means a bad book of its kind, though its information is of a very general and elementary character.

The Classification of the Sciences (London: Williams & Norgate, 1864). The author of this pamphlet is doing battle with M. Compte, and for many reasons we sympathize with him to the fullest extent. Compte can hardly be right in deprecating an inquiry as to how organic beings originated, and all scientific men will side with Mr. Spencer in opposing such an opinion.

An Inquiry into the Nature of Heat, by Zerah Colburn (Spon, 1863), contains some very serious reasons for doubting the presently accepted doctrine that heat is a motory force. To say that the author's views are sound, would in the present condition of science be asserting too much, but they may fairly be said to be both instructive and intelligibly rendered.

Atmospheric Electricity, by Reuben Phillips (Hardwicke, 1863), contains a number of papers, some of which were, and others of which were not, read before the Royal Society. Its matter is not exceedingly original, but it will interest those who are pursuing the study of physics.

SCIENTIFIC SUMMARY.

AGRICULTURE.

A New Method of Producing an Artificial Manure has been suggested to the Academy of Sciences by M. Duponchet. It is in part an application of the ordinary method pursued by Nature. All natural soils result from the breaking down of rocks by means of the united action of air and water. He proposes to take the lands of Gascoyne, which are now almost barren, and to render them fertile in the following manner: streams of water containing mud are to be allowed to flow for years over the plains (which must be enclosed), and in this way after a certain period a stratum of silt will be deposited upon the surface of the land, which, when mixed with ordinary manures, will render this part of the country productive. The scheme is decidedly ingenious; but is, we should think, of a character not well adapted to its success in a pecuniary aspect.

The Functions of the Roots of Plants.—M. Henrici has made some ingenious and interesting observations on the functions of roots in supplying water to the plant, and in the development, under certain conditions, of special roots destined for this purpose. It is a matter of not unfrequent occurrence, that plants send roots into wells, cisterns, drain-pipes, &c., where they exist in continual contact with a body of water. In drain-pipes, the roots of plants usually considered to be free from aquatic tendencies, such as rape, sometimes accumulate to a surprising extent. M. Henrici surmised that the roots which most cultivated plants send down deep into the soil, even when the latter is by no means porous or inviting, are designed especially to bring up water from the subsoil for the use of the plant. The following experiment was devised for the purpose of establishing the truth of this view. On the 13th of May, 1862, a young raspberry plant, having but two leaves, was transplanted into a large glass funnel filled with garden soil, the throat of the funnel being closed with a paper filter. The funnel was supported in the mouth of a large glass jar, and its neck reached nearly to the bottom of the latter, where it just dipped into a quantity of water. The soil in the funnel was at first kept moderately moist by occasional waterings. The plant remained fresh, and grew slowly, putting forth new leaves. After the lapse of several weeks, four strong roots penetrated the filter, and extended down the empty funnel neck, through which they emerged on the 21st of June, and thenceforward spread rapidly in the water of the jar. From this time the soil was not watered any more, but care was taken to maintain the supply in the jar. The plant continued to develope slowly; its leaves, however, did not acquire a vivid green colour, but remained pale and yellowish; they did not wither until the usual time late in autumn. The roots continued to grow, and filled the

water more and more. Near the end of December the plant had seven or eight leaves, and was about eight inches high. The water roots were vigorous, very long, and beset with numerous fibres and buds. In the funnel tube the roots made a perfect tissue of fibres. In the dry earth of the funnel the roots were less extensively developed, yet exhibited some juicy buds. The stem and the young auxiliary leaf buds were also full of sap. The water roots being cut away, the plant was put into garden soil, and placed in a conservatory, where it grew vigorously, and in May produced two offshoots.

This experiment demonstrates in the most incontestable manner that certain plants extend a portion of their roots into the subsoil chiefly for the purpose of gathering supplies of water. It is, therefore, an additional argument in support of Baron Liebig's explanation of the cause of what is known to practical farmers as clover sickness. — *Vide* Henneberg's "*Journal für Land-wirthschaft*," 1863, p. 280; and the "*American Journal of Science and Art*," vol. xxxvii. p. 136.

ASTRONOMY.

The New Planet.—The planet stated to have been discovered by Mr. Pogson in February last, which was supposed to be the eightieth of the group, and which had already received the name of *Sappho*, turns out to be the same as that detected in October, 1862, at Copenhagen, known as the seventy-sixth, or *Freia*. Such mistakes must be unavoidable at present, from the great number of those little objects, whilst the ephemerides are not always exact. Another case of the same kind occurs in the observations of the asteroid observed by Mr. Pogson for *Concordia*, but which it has also been found by M. Oppolzer are those made of the planet *Freia*.

Satellite of Sirius.—Numerous observations of this interesting object, supposed to be the almost obscure body which disturbs the larger star, have been made during the last spring months by MM. Lassell (at Malta), Struve, Dawes, &c. By Struve's *observations* it would appear, however, that the two stars are only placed in accidental juxtaposition. That observer, however, thinks that this conclusion is doubtful, as in that case the small companion could scarcely have escaped the attention of Sir W. Herschel at the close of the last century, when, if not physically connected with Sirius, it would be one minute distant to the south-west. As Sirius was frequently observed by Sir W. Herschel as a test object, M. Struve thinks that the companion could not be overlooked, unless there is a great variability in its light. According to M. Struve, it is not much below the eighth magnitude, as it could be seen quite distinctly a few minutes after sunset, at a low altitude, whilst stars of the ninth magnitude at high elevations were seen with difficulty. Mr. Lassell states that the small star did not appear to him as a very small point, but was deficient in brilliancy, and like the fifth star in the trapezium of Orion, which has a dull reddish hue. Mr. Dawes was also surprised to find in what a strong

twilight it was visible, but thinks that the very best atmospheric conditions are necessary to detect it.

New Nebulæ.—MM. Lassell and Marth have detected nearly 200 new nebulæ with the great reflecting telescope now mounted at Malta. The last winter in that island was, however, unprecedentedly unfavourable for astronomical observations.

Solar Envelope.—The discussion on the "willow leaves," or luminous isolated flakes which cover the sun's surface, still continues. It would seem that the same appearances have been discovered by different observers; but having been examined with various magnifying powers and appliances, they have been described in independent terms by each, and only differ in language. Mr. Dawes considers the term "willow-leaves" as totally inapplicable to the shapes seen by him. A far less objectionable term he holds to be that of *rice grains* applied by Mr. Stone; but even this conveys an idea of uniformity in shape and size, which they do not possess. He proposes that of *granules*, which expresses nothing in regard to their exact form or precise character. Recent observations have shown that their forms and sizes are so various as to defy any attempt to describe them by any comparison. The rarest of all forms Mr. Dawes found to be that of the long and narrow, and he could not find a single one which could be compared to a willow-leaf. One might be four or five times as large as another near it; one resembled a blunt and ill-shaped arrow-head, whilst another within 5″ of it was an irregular trapezium with rounded corners. Mr. Dawes met with none of the *interlacing* seen in Mr. Nasmyth's drawings, nor with the objects which he has depicted as the "exact form of those remarkable structural details." It appears, however, that Mr. Nasmyth does not now regard them as of exact and uniform figure. Mr. Dawes is of opinion that the granules are larger as well as brighter on the bright portions of the sun; and that in a mass of granules they are very nearly all of equal brilliance, faint and bright ones not being intermixed. The bright portions of the sun immediately surrounding the larger spots were found to be destitute of granulations, as also the faculæ, which would seem to Mr. Dawes to prove that the commotion which had produced those spots had heaped up in large masses the ordinary luminous photosphere of the sun. Mr. De la Rue maintains that Mr. Nasmyth has made a substantial discovery. Mr. Talmage was never able to see any of the appearances described by MM. Dawes and Nasmyth. Mr. Dunkin estimated that about three hundred of those granules lay in a space of 56″ by 48″. Mr. Dawes states that the appearances recently discovered by the Greenwich observers are exactly the same as found by himself sixteen years ago, and after four years' attentive observation, he came to the conclusion that these brilliant objects "were merely different conditions of the surface of the comparatively large luminous clouds themselves," in respect to form, brilliancy, and elevation. An objection has been made that the small aperture of the solar eye-pieces used by Mr. Dawes probably interferes with the distinctness of the object viewed; but it has been ascertained that at the centre of the field of view such is not the case.

Photograph of Sun.—Although the progress of solar photography has

been hitherto very satisfactory—the mottled and luminous streaks in the neighbourhood of the spots being shown by those of M. De la Rue—yet it would appear that the time of exposure must be carefully attended to, or the difference between the photographs and the eye-pictures becomes very apparent. In those taken at Ely by Professor Selwyn, the small exposure adds to the clearness of the fainter features of the sun, whilst with those taken at Kew, a long exposure blots out all the minute details. This latter is, however, purposely done, as it is only to obtain sharp definition of the margins and spots that observations are carried on at Kew. Mr. De la Rue attributes the better definition of the details of the faculæ to the fact of the Kew instrument being in really better chemical focus. In all the very minute features, however, the eye must be depended on.

Comet of December 28th, 1863.—Dr. Michez, of the Observatory of Padua, has calculated an elliptic orbit of this comet, which, it will be remembered, was considered as identical with those of 1490 and 1810. It would seem, however, that its identity with the last comet is doubtful, as a period of about 108 years satisfies the observations of the present year. This period represents also very imperfectly the comet of 1490, although the other elements are not far wrong. As this, however, is the principal one, the identity must be considered as yet doubtful.

Relation of Periodic Times.—Mr. Finlayson, of Dover, points out the following singular proportion:—The period of rotation of the earth on its axis is in the same proportion to the periodic time of moon round the earth as that of the period of rotation of the sun on its axis is to the periodic time of Mars round the sun.

Nebula of Eta Argûs and Southern Double Stars.—Mr. Powell observing at Madras, confirms his own and Mr. Abbot's previous suspicions of the changes in the nebula surrounding Eta Argûs. He states that since 1860, the whole nebula has faded away very considerably, and has also altered its form; the star now being left quite isolated, and out of the nebulous matter altogether. It is to be remembered that the star is one of the most remarkable variable ones, and the phenomenon of the star and nebula varying in brightness at the same time resembles that of the disappearance of the small star and telescopic nebula of Taurus a few years since. Mr. Powell has also made some good observations on the remarkable star, Alpha Centauri, which is now at an interesting part of its orbit, as the distance is now decreasing. Gamma Coronæ Australis he finds has described 20 degrees during the last four years.

Early Observations of Uranus.—Two early observations of Uranus have been discovered by Mr. Hugh Breen in Dr. Bradley's unpublished Greenwich Observations. The dates are 1748, Oct. 21, and 1750, Sept. 13. At the latter time it was near *Alpha Capricorni*. On both occasions it is noted as being of the sixth magnitude.

Chinese Record of Eclipses.—Out of the thirty-six solar eclipses which Mr. Williams has extracted from the Chinese records, the Astronomer Royal has found thirty-two to agree with those in the *Art de Verifier les Dates*. Two appear impossible; but Mr. Williams has found that one of those is an erroneous repetition. Two are not real eclipses, being probably

set down as memoranda of dates when eclipses were to be looked for, being the times of new moon.

BOTANY.

Respiration of Fruits.—In a paper lately read before the French Academy, M. Fremy gives some interesting details concerning the ripening process in fruits. In the development of the latter there are three stages, which are distinguished not only by physical but by chemical features. The first period is that of development *par excellence.* The fruit during this stage is generally of a green colour, and acts on the atmosphere in the same manner as the leaves; that is to say, it causes the decomposition of carbonic acid and the liberation of oxygen under the influence of light. In the second period, which is that of maturation, the green colour of the fruit is replaced by yellow, red, or brown; the vegetable matter no longer decomposes carbonic acid, but absolutely developes it by the combination of its carbon with the oxygen of the air. Slow processes of combustion take place in the cells of the pericarp, which cause the disappearance of the soluble matters usually found there; the tannin is first destroyed and the acids follow. At this stage the fruit is eaten. The third period is that of decomposition; its final object is the destruction of the pericarp and liberation of the seed. At this time the air enters the cellules, and, acting in the first instance upon the sugar, it gives rise to alcoholic fermentation, marked by the disengagement of alcohol, which in operating upon the acids of the fruit gives rise to ethers, thus producing the peculiar aroma. This action when continued, destroys the structure of the fruit, and terminates in complete destruction of the tissues.—Vide *Comptes Rendus*, t. lviii. No. 15.

Raphides as Useful Characters of Plants.—Professor Gulliver continues his valuable researches concerning the absence from or presence in plants of these crystalline bundles. He now asserts, that by means of the raphidic features alone, the *Epilobium* and *Lythrum* may be distinguished from each other at any period of their growth.

Per-centage of Quinine in Jamaica Cinchonas.—The experiments which Dr. Daniell conducted to determine the proportion of quinine contained in the "barks" grown in Jamaica, demonstrate that the leaves of *C. succirubra* produce as much as 1·00 per cent. of this valuable drug. The characteristic white acicular crystals deposited upon the evaporating glass, in the course of experimentation, could be plainly discerned by the naked eye, and presented a contrast to the larger, flat, four-faced oblique prisms of cinchonine obtained from the residual liquor. The plant employed is that known to druggists as the red bark, and is not only the most valuable commercially, but, according to Mr. Wilson's experience, the most easily propagated of all the species.—Vide *Journal of Botany*, No. xvi.

The Flora of the Scilly Isles is, according to Mr. F. Townsend's views, derived from the same source as that of the mainland, both having been produced by migration and not by transport. All the species hitherto met with in these islands occur also on the nearest mainland, with the excep-

tion of *Arthrolobium ebracteatum*, a native of the Channel isles and of France. If the law of migration from specific centres be granted, the plants of French type must have spread into these islands and the mainland from the south or south-east, and in both cases the spreading must have taken place during the existence of a vast continent, now partly occupied by the sea, which flowed in as a barrier before the *Arthrolobium* spread further than the Scilly isles.—Vide *Journal of Botany*, April, 1864.

Action of Light on Plants.—The veteran chemical botanist, Boussingault, has been inquiring into the difference between the chemical products arising from plants exposed to light and darkness. He finds that plants when germinating,—in other words, when living under ground,—tend to develope carbonic acid by allowing their carbon to combine with oxygen, and give rise to water by allowing the latter element to unite with their hydrogen. Hence, while in this condition they are rapidly losing weight. When, however, the young leaves appear above the surface and the plant is exposed to light, the weight increases, the carbonic acid of the atmosphere is decomposed, its carbon being retained. These normal results may be artificially produced in the case of mature plants, by exposing them to the influences of light and darkness. When submitted to light they increase in weight; but when in darkness they gradually lose their bulk, and decompose.—Vide *Comptes Rendus*, May 16, 1864.

Identity of the Vine-fungus and that producing Epidemics.—That the fungi which produce such distinct results as grape failure and diphtheria are one and the same species is certainly startling. MM. Vitray and Desmartis are of opinion that there is no distinction between the two species—*Oïdium albicans* and *O. Tuckeri*. This conclusion has been formed from the circumstance that there is a sort of connection between the appearance of the vine disease and that of various forms of epidemic laryngeal maladies. The spread of the first has been followed by that of the second. It might, of course, be objected that botanists do not regard the two forms as belonging to the same species; but then they are of the same family and genus, and there is no reason to suppose that *protëism* does not occur here as in other instances.—See a *Mémoire* read before the French Academy, May 9, 1864.

A New Substitute for Coffee has been proposed by M. Prevet, who suggests the employment of the seeds of the carob-tree instead of the fruit we use at present. It possesses a very agreeable flavour even without being sweetened with sugar; and, apart from an economical view, it might be taken with benefit by those who find coffee too stimulating.

Persistence of the Fertilizing Power of Pollen Grains.—M. Belhomme has published his investigations upon this subject. He has discovered that the pollen of monocotyledons preserves its properties for a much longer period of time than that of the dicotyledons. He experimented upon the following natural orders: *Leguminosæ*, *Rosaceæ*, *Myrtaceæ*, *Umbelliferæ*, *Cacteæ*, *Cruciferæ*, *Malvaceæ*, *Solanaceæ*, and *Boraginaceæ* of the latter group, and he found the pollen as fertile at the end of three years as it was at first. His experiments on monocotyledons were made upon the *Liliaceæ* and *Amarylidaceæ*, the pollen grains of which retained their fertility for a period of six years. Fertile and barren pollen may be

contra-distinguished at a glance : if the grains have lost their fecundating property they feel like dry powder when placed upon the palm of the hand ; if, however, they still possess it, they adhere to the hand and seem as though they had been slightly moistened. In the latter case, it is evident that they exhibit the same physical qualities as the fresh pollen.

The Male Flower of Gymnosperms is supposed by Dr. Eichler to be composed as follows :—Each anther-bearing scale of the amentum is a single leaf altered by metamorphosis, that is to say, a single stamen. This is proved in many ways. These leaves frequently assume forms passing into true leaves, this transition having been observed in the cypress and other kindred plants. In the hermaphrodite aments of the pine tribe, stamens are found in place of the outer scales which are true bractiform leaves. Moreover, the development of the anther-bearing scale shows that it springs from the axis, exactly like a true leaf, and is in no way formed by the union of several distinct parts.—Vide *Natural History Review*, No. XIV.

Geographical Distribution of the Byblus-Rush.—Mr. Hogg in commenting upon the discovery of this plant in the upper Nile regions, observes :—The Byblus-Rush was once so common on the banks of the Nile that Ovid assigned the epithet *Papyrifer* to that holy river. Nor was the plant itself esteemed less holy, inasmuch as it was used by the Egyptian priests, for the ornamentation of their statues and temples, and for a frequent model of columns, and as a representation in the ancient hieroglyphics. But of late years travellers have *not* found any of it in the *Lower* Nile and its adjacent waters ; and thus have been confirmed these words of Isaiah (c. xix. v. 7), "The paper-reeds by the brooks . . . . shall wither, be driven away, and be no more."—Vide *Annals of Natural History*, April, 1864.

Openings in Legumes.—Mr. A. H. Church has lately pointed out a very interesting peculiarity in the structure of the pods of leguminosæ. Having observed that in the process of drying, a considerable quantity of water is evaporated, he was anxious to discover whether any channel existed, through which the watery matter could escape. At first he supposed that the liquid permeated the membranous walls of the legume, but a careful examination resulted in the discovery of a small oval foramen close to the proximal end of the ventral suture. This was detached in several specimens of *Faba vulgaris*. It was also observed in other species. The object of the arrangement is to prevent the dehiscence of the valves of the legume, and consequent shedding of the immature seeds. Mr. Church proposes to apply the expression *aëropyle* to this aperture.

Range of Woodsia Glabella.—The distribution of this species is far wider than is usually supposed. It was found by Mr. Backhouse, in Norway, at an elevation of a *thousand* feet above the level of the sea, in fact just below a permanent snow patch : *Cystopterus alpina* and *Asplenium viride* were growing near it. The station discovered by Mr. Backhouse was in latitude sixty-nine and a half, and since the fern has also been observed in the Tyrol, we may now expect to find it distributed over the intervening country.

Vegetation of the Kilkee Cliffs.—In a paper read before the Botanical Society of Edinburgh some time ago, Mr. James Robertson gave a sketch of the botanical features of the Kilkee sea-cliffs. This part of the Irish coast-line is exposed to the full violence of the Atlantic winds and waves, and thus a rock two hundred feet above high water is so copiously supplied with saline spray, as to afford sustenance to a colony of periwinkles which fringe its summit. Notwithstanding this, the marine plants which are found at heights varying from 150 to 400 feet, and which grow in a very stunted manner, illustrate in a striking way the physiological law that if plants can do nothing else, they must produce their flowers and fruit. The flora approaches the alpine type in character, doubtless because of the peculiar external conditions.

Perennial Character of Spitzbergen Plants.—We learn from the valuable papers of Mr. Malmgren in the May and June numbers of the Journal of Botany, that the plants of Spitzbergen are all perennial, and have a tendency to grow in small tufts. It is well known that organic substances decay very slowly in the Arctic regions. A wooden grave-cross, raised half a century ago, looks as though it were of yesterday; and the dry remains of the previous year's growth of plants stand almost unchanged beside the new shoots of the perennial root. One may, indeed, almost say that stones and minerals decay more speedily in these regions than organic substances. But why are the plants all perennial? The reason is obvious. It entirely depends, so to speak, on wind and weather, whether a plant can produce ripe seed during the short summer. No doubt they generally do so, but if in any year they failed, plants having an annual root must of necessity be lost, while the continued existence of the species with perennial roots would be secured.

Caproic Acid in the Flowers of Satyrium Hircinum has recently been detected by M. Chautard. He distilled the flowers with water, and neutralized the acid distillate with potash. The salt thus formed was dried, acted on by sulphuric acid, and again distilled, when caproic acid passed over, and was easily recognized by its peculiar odour. M. Chautard believes that this compound is also present in the flowers of *Orchis coriophora*.

Smut in Wheat.—A memoir on this subject has been presented to the French Academy by M. Lavalle, who makes the following statements as the conclusions at which he has arrived :—

1st. The development of this fungus brings about results, often destructive of entire crops of wheat and other cereals.

2nd. When once it has occurred in any locality, it is likely to become endemic there.

3rd. It invariably appears at a fixed period—summer,—and at the very time when the seed has been fecundated and has begun to undergo development.

4th. It may attack not only wheat, but other cereals, whilst all plants, wild or cultivated, of a different order are unattacked, even though growing among the corn.

5th. The various fungoïd maladies of cereals are all due to the same parasite, more or less developed.

Growth of Cryptogams in Eggs.—It is stated by M. Milne Edwards, that the presence of vegetable organisms in the interior of eggs is not a fact in support of spontaneous generation doctrines. Signor Panceri has discovered, that when certain cryptogamic plants are allowed to develop themselves on the outer surface of the shell they extend to the interior. The passage is effected through minute channels, which though imperceptible to the naked eye, are recognized when magnifying powers are employed.—Vide *Comptes Rendus*, May 23, 1864.

Function and Circulation of the Latex in Ficus Elastica. — M. Faivre asserts that the latex in the latter species is a sap elaborated by the leaves, and indispensable to the development of the various organs of the plant; that, whilst it descends both by the centre and periphery of the stem, it passes to the extremities and nourishes them; and that it travels also toward the superior portions of the axis and contributes material for their growth.

Chinese Diatomaceæ.—A very interesting article on this subject appeared in the last number of the *Microscopical Journal.* It was written by Mr. Lauder, M.R.C.S., who informs us that the diatoms are generally very abundant in Hong-Kong harbour; so much so, indeed, that in a few minutes, by means of a small muslin towing net, a jelly-like mass about the size of a wall-nut is obtained, consisting of about equal parts of diatoms and entomostraca. It is remarkable, too, that in different months, different forms are prevalent, giving distinct characters to the gatherings. In January very few diatoms can be obtained. In February the Coscinodisceæ are most plentiful. In March and April, numerous species of Rhezosolenia and Chætoceros make their appearance, and about the end of the latter month almost all these organisms have disappeared. Of the genus Chætoceros, Mr. Lauder discovered no less than eleven new species.

National American Herbarium.—We find it stated in the *Natural History Review*, that two years ago Professor Asa Gray made the munificent offer to the University of Cambridge, Massachusets, of his valuable herbarium and library, upon the condition that a suitable fire-proof building should be erected for their reception, and a fund invested for their adequate maintenance. The subject has been in abeyance till recently, when a banker of Boston liberally offered to defray the cost of the required building, provided others raised a fund to meet the current expenses of the establishment. It is to be hoped that so liberal an offer will be at once accepted. Then Professor Gray will be enabled to complete his projected work, the "Flora of the North American Continent," a work for which he has already accumulated much material, and which few, if any, are so well qualified to complete successfully.

Is the Radicle the first Internode of the Stem?—This question is answered in the negative by Professor Olliver. He regards the cotyledons as marking the first node in the stem, and consequently as indicating the zero of the scale: hence he considers that the radicle is not to be looked on as part of the stem or *ascending* axis in the same sense as the other internodes of the plant may be so regarded.—Vide *Natural History Review*, April, 1864.

Seeds of Bonapartea juncea.—The seeds of this plant have been obtained

from a specimen in the Botanic Gardens of Rochester, New York. Near the upper part of the stem seeds were found, which on being planted, germinated, and in a short time produced three young and healthy individuals of this species. The head of the old plant slowly decayed, a part of the leaves fell off, and by another summer it will have ceased to exist. It is now known, therefore, that the seeds of this plant will ripen in a warmed conservatory.—Vide *Silliman's American Journal of Science*, 2nd series, 109.

Spiral-growing Fucoïd Fossils.—Professor Hall, of New York, contributes to the last "Report of the Regents of the University" a paper on the above subject. He has found a series of these organisms in the palæozoic rocks of New York, and he proposes uniting the different genera under one, which he terms *Spirophyton*. From the fact that these forms have occurred solely in Devonian rocks, he thinks they may henceforth be regarded as indicating strata of that period.

The Fossil Flora of the Bohemian Rothliegenden is given in a most instructive tabular scheme which appeared in the *Geologist* for June, and to it we must refer those of our readers who are interested in the subject.

Plants producing Double Flowers have received the attention of Dr. Seemann, the well-known editor of the *Journal of Botany*. He considers that the bulk of plants producing double flowers is undoubtedly indigenous to the northern hemisphere. In Polynesia and the whole of Australasia not a single species with double flowers has turned up; but there are in South Africa and South America at least a few plants, the stamens of which are converted into petals. It is impossible to say whether the absence of double flowers from Polynesia and Australia, is owing to the fact that there are no observers in those parts who at once seize and transplant them into a garden, or whether they really never occur. Civilized men having taken a peculiar fancy to double flowers; they are safely lodged in garden and greenhouse whenever they spring up; and hence all countries, longest or most highly-civilized, have, as the case now stands, supplied the greatest number of these products, China and Japan boasting of the most perfect of all, the camellias. Dr. Seemann's list embraces the names of 279 species, of which 234 are exogens, and the remainder belong to the Monocotyledon division. Two of the plants are apetalous.

CHEMISTRY.

A new Mode of producing Aldehyde has been described by M. Carstanjin. It is known to chemists that very many methods of preparing these compounds are already employed; for example, they may be obtained by the oxidation of either albumen or alcohol, in the distillation of salts from fatty acids, and of albuminoid substances, and by dehydrating glycols. The *modus operandi* adopted by the chemist we allude to is as follows:—Ethylamine is poured on crystallized permanganate of potash, and the liquid, which is at first violet, turns green, and on being shaken becomes

brown, effervesces, and gives off acetic aldehyde, which is at once perceived on account of its odour.—Vide *Journal de Pharmacie*, xlv. 100.

The Constitution of Wood-spirit is the subject of a paper lately read before the Chemical Society and communicated by Mr. Dancer, of Manchester. The author's experiments led him to believe that there were four distinct compounds present in the crude spirit. By means of fractional distillation and other processes he was enabled to demonstrate, that besides the bulk of wood naphtha, which was true methylic alcohol, there were contained in this spirit acetate of methyl, acetone, and bimethyl-acetal. The substance formerly described under the name of xylyl was not found present.

The Action of Red Phosphorus on Sulphur.—M. Lemoine finds that when red phosphorus and sulphur are allowed to react on each other they produce a new compound having the formula $P_2 S_3$. This substance is always produced in whatever proportions the two elements employed may be. It is of a very stable character, not oxidising in the air, belonging to the "right rhombic prism" system, and boiling at a temperature of about 350° centigrade. It is very soluble in sulphide of carbon and chloride of phosphorus, and may be separated from the latter solution by means of water. It is also soluble, but with decomposition, in ether and alcohol. The method of producing it consists essentially in heating together the two elements, then adding sulphide of carbon, which dissolves the new body, and thus admits of its separation from the others.—Vide *Comptes Rendus*, lviii. 20.

Production of gummic Acid from Glucose.—When a solution of acetate of copper is supersaturated by a slight excess of alkali, the copper reduced by means of glucose, and the liquid neutralised by acetic acid, an acid compound may be obtained by precipitation with acetate of lead. This compound, which is really a gummate of lead, must now be decomposed by sulphuretted hydrogen, and the resulting liquor evaporated at a gentle heat. By this means an acid will be obtained which crystallizes in rhomboid prisms, and has a taste resembling that of citric acid. Gummic acid loses no water at 100° centigrade, it browns at 130°, and is decomposed by a heat of 150°. It has the formula $C_6 H_5 O_{10}$, is soluble in water and alcohol, and forms salts with baryta, lead, and silver.—Vide *Bulletin de la Société Chimique*, iii. 197.

A new silica Compound.—M. Marignac states that when a gelatinous solution of silica is boiled with an acid solution of tungstate of potash or soda it is dissolved. This solution now becomes alkaline, and contains a new acid compound, in which *one* equivalent of silicic is combined with *twelve* of tungstic acid. This new combination is termed *silico-tungstic* acid. It is a strong acid, very stable, which forms two hydrates, obtainable in magnificent crystals. Acid tungstate of ammonia under similar circumstances gives an acid, in which the equivalent of silica is united with ten of tungstic acid, and which is therefore designated *silico decitungstic* acid. This acid is more difficult to separate, the hydrate does not crystallize, and on drying it easily parts with some of its silica, and forms a third acid—*tungsto-silicic*, in which the constituents are present in the same proportions as in silico-tungstic. All these acids are quadribasic; they are as soluble in water as alcohol; and anhydrous ether forms with

them a sort of syrupy liquid. The salts of these acids form solutions in water of very great density; a solution of neutral silico-tungstate of soda, for example, may be made so dense that it will allow glass and quartz to float upon its surface. Hence, as Mr. Crookes suggests, this solution may possibly form an excellent material for prisms.—Vide *The Chemical News*, No. 232, p. 238.

How to prepare Sub-oxide of Copper. — The following process for the preparation of sub-oxide of copper is given by Herr Boettger:— Dissolve, in two parts of hot distilled water, one part of crystallised sulphate of copper, one and a half of tartrate of potass and soda, and two parts of cane-sugar. When the solution is complete and tartrate of copper formed, add one and a half part of caustic soda. By boiling the mixture, the sub-oxide of copper is gradually precipitated, losing its odour completely, as in saccharometric experiments. The product is of a beautiful red colour, and, after it is washed and dried, will keep without alteration.—Vide *Chemical News*, May 7th, and *Jour. für prakt. Chemie*, xc. 163.

The Composition of Rain-water.—M. Bobierre, who lately presented a memoir to the French Academy, concludes from his experiments on and examination of rain-water:—

1st. That the composition of specimens collected in large towns is extremely variable.

2nd. These variations refer more especially to the proportions of ammonia, nitric acid, and organic matters.

3rd. The examination of specimens collected at different heights shows that there is a relation between the composition of the water and the altitude at which it is received from the atmosphere.

4th. In rain-water collected at Nantes in 1863, at a height of 47 metres, the proportion of ammonia was 1·997 gramme per cubic metre, whilst that collected at a height of seven metres in a low and unhealthy neighbourhood contained 5·939 grammes per cubic metre of the same substance.

5th. The proportion of nitric acid increases as that of ammonia diminishes.

6th. The evaporation of 372·50 litres of Nantes rain-water proved that the variation of alkaline chlorides and organic matter is much more marked than that of other substances.—Vide *Comptes Rendus*, lviii. 17.

Chemical Preservation of Statues.—This may be achieved by following the processes lately described at the French Academy. One of these methods is that of M. Dalemagne, who thinks that coating such objects with silica is quite sufficient to ensure their preservation. In proof of this he calls attention to the circumstance that certain busts which were submitted to the process of *silicatization* ten years ago are now in a state of perfect preservation, whilst others of the same age placed under the ordinary conditions of the atmosphere, and even to which considerable attention had been paid, are now in a state of more or less marked decay.

A crystallized Hydrate of Soda.—Herr Harms has obtained a well-crystallized and definite hydrate of soda, by exposing a solution of caustic soda of density 1·385 to a temperature of 0° centigrade. The crystals are often very large, have a glassy lustre, and are perfectly transparent and

colourless. As the author states that the crystals may be obtained very pure, even from solutions containing sulphate and chloride of sodium, it seems probable that they will afford a ready means of obtaining pure soda for laboratory purposes. The formula of the crystallized hydrate is Na O, + 8 H O; by long standing over sulphuric acid the compound loses four equivalents of water. Rose, who examined the crystals, found them to be *oblique rhombic*.—Vide *Poggendorff's Annalen*, cxix., and *Silliman's American Journal*, 1864, No. 109.

A non-arsenical green Colouring Matter has been discovered by Dr. Elsner in a very accidental way. He was requested to analyse a quantity of green powder, which was termed green cinnabar, and during the operations to which he submitted it he observed that the compound was not arsenical, but was composed of various proportions of prussian-blue and chromium green. He found that it possessed every possible degree of shade between the two tints. This colouring matter is well adapted to the manufacture of paper hangings, but cannot be used for walls on account of the prussian-blue, which would undergo change; neither can it be used in colouring bon-bons, because of its injurious qualities. The following is the recipe for its preparation: Make a solution of yellow chromate of potash, and another of yellow prussiate of potash, and then mix the two. Dissolve separately, in water, some acetate of lead and iron, and add this solution to the others. In this way a precipitate will be obtained, whose tint will depend on the proportions of the ingredients employed; of course the larger the quantity of acetate of lead and chromate of potash, the lighter will the colour produced be. The precipitate should be carefully washed, and dried at a gentle heat.—Vide *Moniteur Scientifique*, v., 382.

Composition of the Harrogate Waters.—It appears from a communication of Dr. S. Muspratt's that the springs of Harrogate, which have been lately so much resorted to by persons suffering from cutaneous diseases, have the following composition: In an imperial gallon there are 41·626 grains of mineral matter, which is thus composed: Carbonate of lime, 10·498 grains, carbonate of magnesia, 1·002, carbonate of soda, 15·093, sulphide of sodium, 2·852, sulphate of magnesia, 4·593, chloride of magnesium, 5·741, chloride of sodium, 1·006, silica, 0·841, traces of carbonates of iron, potass, and manganese, and also of ammonia and chloride of potassium. Dr. Muspratt thinks that Dr. Hoffmann's assertion, that part of the sulphuretted hydrogen of these waters is in the free state, is open to considerable doubt.—Vide *The Chemical News*, No. 228.

Chemical Professorships.—In accordance with the suggestions of the Commissioners, the Royal Academy of Arts has determined to found a chair of Chemistry. We learn also upon excellent authority that the chair in Berlin, held by the late Professor Rose, has been offered to and accepted by Professor H. Kopp, of Giessen, who will soon enter upon the duties of his new office. Dr. Hoffmann's refusal of Rose's chair resulted from his having been offered a very large sum by the Bonn authorities for the construction of a new institute of Chemistry, over which he is expected to preside.

Chloro-carbonic Acid is said by Dr. Schiel to be formed when a perfectly dry mixture of chlorine and carbonic acid is passed through a

porcelain tube filled with pieces of charcoal and heated to redness.—*Zeitschrift für Chemie, etc.*, vii., p. 220.

A new Acid isomeric with sulpho-vinic Acid was obtained by Mr. Northcote, by adding sulphuric acid to an alcoholic solution of potash which had been kept for some years. Heat is not required for its production, thus proving its distinctness from the sulpho-vinic compound.—Vide *The Chemical News*, 227.

Decomposition of Water by Phosphorus, Arsenic, and Antimony, and Evolution of Ammonia.—The solution of phosphorus in nitric acid, concentrated or diluted with one or two volumes of water, is, as is well known, effected with disengagement of nitrous vapour, abundant if the acid is concentrated, and diminishing in proportion as it is more diluted. In any case if, when the solution is effected, excess of potash is added to the hot solution, sufficient ammonia is disengaged to become evident, both by its odour and by reagents. Whether normal or amorphous phosphorus is used in this operation, the phenomena and the products are identical. It was, then, interesting to ascertain whether the fact of the production of ammonia was observable with the bodies forming part of the phosphorus group, as arsenic and antimony. In order to determine this, M. Personne operated with arsenic and with antimony purified three times by fusion with nitre. These two bodies, pulverised and heated, were attacked by nitric acid, diluted with its volume of water. Under these circumstances, arsenic is easily attacked, giving arsenious and a little arsenic acid. Antimony, on the contrary, is attacked with more difficulty. However that may be, if ammonia is looked for in the liquids obtained, it will be found that these two bodies have behaved like phosphorus, with this difference, that phosphorus gives more ammonia than arsenic, and arsenic more than antimony. The phenomenon of the formation of ammonia by the decomposition of water under the influence of nitric acid has hitherto been observed only with metals of the third and fourth sections, as iron, tin, zinc, &c. We now see that this phenomenon is not limited to these metals, but belongs equally to the metalloids of the phosphorus group.

The Preparation of Iodide of Ammonium.—This haloïd salt is thus prepared by Dr. Jacobsen: he dissolves equivalent weights of pure iodide of potassium and pure sulphate of ammonia in the smallest possible quantity of boiling distilled water. One part of sulphate of ammonia will require about one and one-third of its weight, and iodide of potassium about half its weight of boiling water for solution. The two solutions are then mixed and well stirred. After the mixture has cooled, water containing fifteen per cent. of alcohol is added, and the whole is allowed to stand for twelve hours. In very cold weather less alcohol will suffice to separate the sulphate of potash formed. According to Schiff, 100 parts of water and 10 of alcohol, at 15° centigrade, only dissolve 3·9 parts of sulphate of potash. The iodide of ammonium, in consequence of its greater solubility, remains in the solution, which is now withdrawn from the precipitated sulphate of potash, filtered and evaporated until a pellicle forms. As the solution is very concentrated, the evaporation is quickly effected. After the crystals of iodide of ammonium are formed, they are drained from the mother-liquor, which, together with the residue of sulphate of potash, is

again treated with dilute alcohol, and the liquor evaporated for a further yield of sufficiently pure iodide. Care must be taken to exclude all acid vapours from the chamber when the evaporation is carried on; and it is well to add, from time to time, to the solution, a few drops of ammoniated alcohol.—Vide *Artizan*, May, 1864.

The Combustion of Gun-cotton.—Some curious facts in connection with the causes of the slow and rapid combustion of gun-cotton have quite lately been pointed out by Professor Abel. He finds that if, even for the briefest space of time, the gases resulting from the first action of heat on gun-cotton are impeded from completely enveloping the burning extremity of the twist, their ignition is prevented. And as it is the comparatively high temperature produced by their combustion that effects the rapid and more complete combustion of the gun-cotton, the momentary extinction of the gases and continuous abstraction of heat by them as they escape from the point of combustion, render it impossible for the gun-cotton to continue to burn otherwise than in a slow and imperfect manner, undergoing a transformation similar in character to destructive distillation. These facts can be illustrated experimentally, by inflaming in the ordinary manner a piece of the compactly twisted gun-cotton, laid upon the table, and throwing a jet of air against the flame in a line with the piece of cotton, but in a direction opposite to that in which the flame is travelling. In the course of this experiment it will be observed that the combustion changes to the slow form, because the flame is prevented from enveloping the burning cotton and thus becomes extinguished. When, however, the current of air is so employed as to throw the escaping gases back on the burning cotton, then the combustion passes from the slow to the rapid form.—Vide Report of paper read before "Royal Society," by Professor Abel, in *The Electrician*, May, 1864.

Decomposition of Uric Acid by Bromine.—In a memoir presented to the Academy of Sciences, M. Hardy alleges that though bromine gives no substitution products with uric acid, yet in the presence of water it splits it up into alloxan and urea, forming at the same time hydrobromic acid. If the temperature be high, more complex changes take place, and parabaric and oxalic acids are formed, with some hydrobromate of ammonia. Chlorine and iodine give results similar to those of bromine. When alloxan is heated to 150° C., it loses two atoms of water; if the heat be carried to 250°, it loses no more water, but acquires the property of giving coloured solutions. When treated with a base, this modified alloxan fixes two atoms of water, and forms an acid identical in composition with alloxanic acid, but which gives coloured salts. For this M. Hardy suggests the term Iso-alloxanic acid. From these researches, he is also led to infer that the purple compound produced in the "nitric acid and ammonia" test for uric acid is not murexide, but simply iso-alloxanate of ammonia. —Vide *Comptes Rendus*, lviii., 20.

Peculiar Properties of Hydrocyanic Acid.—The following may be given as the general conclusions at which MM. Bussy and Buignet have arrived:—

1st. When this acid is mixed with water, the temperature is very decidedly diminished, and the volume of the mixture contracted.

These two effects proceed directly, the one being associated with the other, and the maximum for both being attained by a combination of three equivalents of water and one of hydrocyanic acid.

2nd. That hydrocyanic acid possesses a powerful affinity for corrosive sublimate, which it retains without forming any definite compound. When the two are mixed together, the temperature becomes elevated, and the affinity is so powerful that it causes the conversion of the protochloride into the perchloride, and produces metallic mercury ; this effect, however, only takes place in the presence of water.

3rd. Other salts act on the acid in the same way, but to a far less extent; but the greater number act by increasing the tension of the vapour.

4th. In certain cases, the result of the action of the process of solution is to separate the hydrocyanic acid under the form of a subnatant stratum, although the quantity separated in this way has no relation to the affinity of the salt which was placed in the water.—Vide *Comptes Rendus*, lviii., 19.

GEOLOGY AND PALÆONTOLOGY.

Fossil Insects of the Carboniferous Formation in Illinois.—In *Silliman's American Journal*, No. 109, we find a valuable paper by Mr. Dana, upon the insects of the latter formation. The species he describes and figures in the contribution referred to, is evidently one of the Neuroptera. In general form and the nervation of the wings, one of the species approaches the *Semblids*. From this fact, and also from the circumstance that the outer wings are so thin as to admit of the abdominal segments, and even the inferior wings being seen through, there is every reason to believe that the insect could not have been one of the Orthoptera. The anterior legs are peculiar in having a large and broad femur, armed above with very slender spines as long as the joint, three of which, though mutilated, are seen in the specimen. Mr. Dana supposes that these limbs were prehensile, as in the Mantis, and this idea is borne out by the fact that the tibia and tarsus are not in sight. Only the left leg in the specimen has the large joint tolerably perfect; in the right, however, it is sufficiently distinct to show that it had the same large size, and was also spine-bearing. This fossil was discovered by Mr. J. Bronson, of the Miami University, and at his request it has received the generic title of *Miamia*, the specific one of *Bronsoni* having been appended by Mr. Dana.

Exogenous Wood in Arenaceous Limestone.—Professor Haughton describes a curious specimen which he found in some of the beds of the yellow sandstone series of the north coast of Mayo, in Ireland. When a section of it was examined under the microscope (× 500 diameter), it presented the appearance of "a bundle of rushes deprived of epidermis, containing elevated disk-like markings." The rush-like appearance represented longitudinal tubes with areolæ or warts on the interior surfaces of their

walls, while the concentric lines of growth (numbering in this specimen sixteen, and marking the age of the plant) being crossed by medullary rays, left no doubt that the plant referred to was a coniferous exogen. This discovery of Dr. Haughton's is another argument against Mr. Jukes' view, that there is a true Devonian system in Ireland. The sandstones of Ireland are essentially strata of the carboniferous system, and are perfectly conformable with the limestone beds which overlie them.—Vide *Dublin Quarterly Journal of Science*, April, 1864.

The Fossils of the Bruniquel Cave.—It is very satisfactory to know that the human and other remains from this grotto have been purchased by the authorities of the British Museum. In January last Professor Owen proceeded to the cavern, and having examined it and observed the splendid collection of human and other bones which it contained, proceeded to bargain with the proprietors for the contents. The news of the professor's visit having reached the ears of the French authorities, MM. Milne Edwards and Lartet were despatched on a commission of inspection. They also recognized the value of the discovery, and presently an offer was made from the French Government slightly outbidding that which was made by Professor Owen, under the necessary reserve of approval by the trustees. The proprietor, however, honourably adhered to his verbal treaty with the Professor, who telegraphed the assent of the trustees. This magnificent collection of fossils—some fifteen hundred, many still embedded in the calcified mould of mud in which they were found, beneath the stalagmite—is now deposited in the British Museum. It would appear, from the communication which Professor Owen made to the Royal Society upon the subject, that some of the human remains stand high in the scale of organization. The skull cap which he found did not present the large frontal sinuses so remarkable in that from Neanderthal, nor did it exhibit any features of an inferior or transitional type. We hope that geologists generally may investigate this matter, and throw as much light upon it as has been already thrown upon the discovery of the Moulin-quignon jawbone.

The Discovery of the Scales of Pteraspis is due to Mr. E. Ray Lankester, who lately read a paper on the tegumentary organs of this fish, before the Geological Society. In this communication, the author, after having pointed out the successive steps by which the genus Pteraspis came to be established, and the grounds on which the opinion as to its fish-nature rests, proceeded to describe the scales in detail. These organs were found by Mr. Lankester at Cradley, near Malvern, and they alone were required to remove all doubt as to the affinities of the genus. The paper concluded with a description of the cephalic shield of *Pteraspis rostralis*. For further information on this subject we beg to refer our readers to Mr. Lankester's article in the present number. See also *The Geologist*, June, 1864.

Probable Fossils of Borneo.—In writing upon this subject, Mr. A. R. Wallace states his opinion that an exploration of the Borneo caves would be attended with results most profitable to geologic science. This island offers a field for exploration unequalled, perhaps, in the globe. Limestone caverns abound in it. There are several very extensive ones in the Sarawak territory itself, and Mr. St. John mentions others in the Bruni coun-

try. The character of the existing fauna, as well as the extent of the land and the height of the mountains, all prove it to be of some geological antiquity. Now, in every other country which has been explored, the animals which have recently become extinct are always allied to those now living in the same region, and are often of gigantic size or remarkable forms. Europe gives us elks, bears, and hyænas; Australia extinct kangaroos and wombats; South America giant sloths and armadillos; according to all analogy, therefore, it may be expected that the caves of Borneo would reward a persevering explorer, not only with fossil tapirs, Malay bears, and scaly ant-eaters, but also with the precursors of the extraordinary lemuroid forms now inhabiting the country—*Galeopithecus*, *Nycticebus*, and *Tarsius*—and with fossil proboscis-monkeys, gibbons and orangs more or less resembling those which now abound in its vast and luxuriant forests. It is not improbable that some human remains may also be found to throw light upon the question of the origin of the Malayan races, and to prove whether a negrito or some still lower race was formerly spread over the whole Archipelago. Mr. Wallace informs the naturalists of this country that a gentleman (Mr. Coulson) is now on his way to Singapore, who would gladly undertake to explore the island of Borneo, should the scientific world defray the necessary expenses.—Vide *Natural History Review*, No. xiv.

The Liassic Strata of Belfast.—Mr. Tate, in a paper read before the Geological Society, has given an outline sketch of the distribution of certain beds of the Lias in the neighbourhood of Belfast. The zones of *Ammonites Bucklandi*, of *Avicula contorta*, and the white lias, occur in the locality referred to. The characters of these subdivisions were described, and sections were exhibited showing the beds as exposed in Colin Glen and at Cave Hill, where the three zones are developed. Sections of the *Avicula contorta* zone, at Woodbarn, were also shown. It is a remarkable feature of these deposits, that in the zone of *Ammonites Bucklandi* that ammonite is replaced by *A. intermedius*.

Origin of the American Lakes.—Professor Hind, of Toronto, who has given considerable attention to this question, has arrived at the conclusion that the great lakes of the St. Lawrence and Winnipeg basins were produced by the action of glacial masses, like those now covering Greenland. It appears that Sir William Logan and most of the American geologists are in favour of this view.

The White Limestone of Jamaica is described by Mr. A. Lennox as including a basement series of sandstones and shells, a hard white limestone, a yellowish limestone, and an uppermost member consisting of dark-red marl; it is estimated to be at least 2,500 feet thick. At the junction of the calcareous rocks with the granite the former is often more or less altered, and thus affords good proof that the latter is of Tertiary age. Mr. Lennox considers that the diagrammatic section of the rocks of Jamaica, prepared by the late Mr. Barret, is erroneous, for the following reasons: 1st, There is no section in Jamaica in which the relation of the white limestone to the Hippurite limestone is seen. 2nd. The white limestone is, in his opinion, of Miocene age; and 3rd, the shelly and sandy beds represented in the section as overlying the white limestone are, he believes, in quite the opposite position. On physical and palæontological grounds, Mr. Lennox states his

belief that the white limestone is of Miocene date, and was probably deposited slowly in a tranquil sea.—Vide *The Geologist*, June, 1864.

The Fossilization of West Indian Corals.—A most valuable paper upon the process of fossilization of corals was presented by Dr. Duncan to the Geological Society at one of its late meetings (April 27). The results of this process, as seen in the West Indian fossil corals, being very remarkable, and having much obscured their specific characters, thus rendering their determination extremely difficult, Dr. Duncan found it necessary to thoroughly examine their different varieties of mineralization, and to compare their present condition with the different stages in the decay and fossilization of recent fossils as seen now in progress. By this means he was enabled to show the connection between the destruction of the minuter structures by decomposing membranes, and certain forms of fossilization in which those structures are imperfectly preserved. It appears from his researches that the filling up of the interspaces by granular carbonate of lime and other substances, as well as the induration of certain species, during a pre-fossil and post-mortem period, gives rise to certain varieties of fossilization, and that the results of these operations are perpetuated in a fossil state. Dr. Duncan describes no less than eight distinct forms of mineralization, viz., calcareous, siliceous, siliceous and crystalline, siliceous and destructive, siliceous casts, calcareo-siliceous and destructive, and calcareo-siliceous casts. In describing these forms, especial reference was made to those in which the structures were more or less destroyed during the replacement (by silica) of the carbonate of lime which filled the interspaces, and during that of the ordinary hard parts of the coral.

In explaining the nature and mode of formation of the large casts of calices from Antigua, the author drew attention to the fact that the silification is more intense on the surface and in the centre of the coral than in the intermediate region ; and when examined microscopically it could be seen that the replacement of the carbonate of lime began by the silica appearing as minute points in the centre of the interspaces and of the schlerenchyma and not on their surface.—*The Geologist*, No. 73.

Fossil Reindeer of Ireland.—Dr. Carte, the well-known curator of the Dublin Society's Museum, has described the head and antlers of a splendid specimen lately found in the east of Ireland. It was discovered at a depth of about five feet from the surface, covered with turf and clay, and lay on marl and blue clay. Some other bones (ribs, &c.) were found associated with it, but unfortunately were not preserved. On comparing the specimen described with the description of the dentition of existing reindeer, Dr. Carte found a perfect agreement in all respects.

The so-called Devonian Formation in Ireland.—Another proof of the accuracy of the view, that the Irish sandstone is really carboniferous, has been afforded by Mr. Robert Scott. In a paper read some time since before the Geological Society of Dublin, this gentleman described some peculiar plants akin to the Lepidodendron, which he discovered in the sandstone beds of the county Donegal. When about leaving the locality, he went into a quarry which had been recently opened, and found a large number of well-known carboniferous mollusca, such as *Orthis crenestria*, *Euomphalus calyx*, &c., associated with the plants, and with other markings of

organic origin. With these he also observed several isolated markings which appeared to be more regular in shape than the fragments of the vegetable remains usually are, and to bear some resemblance to fish-scales. From this quarry he afterwards obtained some fish remains, and amongst them the palatal tooth of a species of *Psammodus*, probably *P. porosus*.

The following fossils were identified : *Sagenaria Weltheimiana, Cucullœa Griffithiæ, Avicula Damnoniensis*, and *Orthis crenistria*. — Vide *Dublin Quarterly Journal*, April, 1864.

The Irish Crannoges.—Mr. G. Henry Kinahan has minutely explored these forms of prehistoric dwellings, and given a great deal of minute detail as to their form and mode of construction. After having described various implements, &c. discovered in the vicinity of the crannoges, Mr. Kinahan concludes—1st. That iron was in use in the early age of the crannoges. This is proved by the presence of knives, but the sharp points on the stakes would lead to the same conclusion ; also the number of bones which must have been used for the sharpening of metal instruments. The cuts which were observed on pieces of deer's horn must have been made with a very fine saw, as there are no marks of graining on the surface. 2nd. That when the crannoges were first built, the surface of the lake (Lough Rea) must have been at least seven feet lower than at present, as is proved by several sections, and by the old turf-banks at the south-east end of the lake, over which there are five or six feet of water. 3rd. That at a subsequent period the western part of the lake must have been twelve feet deeper than at present ; this being proved by the fact that there are at least six feet of shell-marl beneath the artificial works. The change in the level of the lake must, in the author's opinion, have been caused by the silting-up of its outlet. The ancient stream from the lake seems to have been at the west end of the town, as in that place there is an alluvial deposit, while at its present outlet there is a strong corn-gravel ; and a little below its present bed there seems to be rock. It is well known that the silting-up of a lake is a very tedious process. First, the weeds grow during the summer, and catch the heavy particles that are coming out with the water ; but in the winter-floods all the weeds are broken down, and most of the accumulated matter is carried away ; so that in a century it would hardly raise the bottom of the stream more than six inches, which would make the crannoges to have been built about 1,400 years before the lake reached its present level. But it must be remembered, that since the town of Loughrea was built the lake could scarcely have changed its level ; for the eastern outlet ran at the foot of the town-wall, and the inhabitants would have kept it open, being part of the defences of their town. Loughrea is more than 400 years old, and hence the conclusion is arrived at, that the crannoges are of pre-Christian origin.—Vide *Transactions of the Royal Irish Academy* for 1863.

Minute Geologic Evidence.—Mr. Edward Blyth has recently pointed out the existence of two very distinct forms of deposit, which are occasionally found on the teeth of fossil herbivora. By an examination of these the geologist is, to some extent, enabled to determine whether an animal has been in the wild or domesticated condition. "There is a small particular or character which generally distinguishes a wild herbivorous animal from a tame one ; and this is, a certain incrustation of brown tartar upon the

teeth." This deposit he did not find upon the porcine relics at the Wrekin, but he fancied, at first, that he detected it upon the teeth of the fossil bovine remains in Ireland. However, after examining the latter more carefully, he noticed a ferruginous deposit from the peat, which might easily be mistaken for the incrustation of brown tartar. "In the one case there would be traces of parasitic life under the microscope—not so in the other case. The incrustation from the peat covered the whole tooth, at least as much of it as was not of the bony alveolus; whereas the tartar incrustation was only upon that portion of the tooth that had not been imbedded in the gum. The latter was conspicuously present in sundry teeth of *Megaceros hibernicus* and of *Cervus elaphus*." We presume that for this reason Mr. Blyth regards these species as belonging to the category of domesticated animals, but we wish the evidence was a little more convincing.—Vide *Dublin Quarterly Journal of Science*, No. xiv., p. 150.

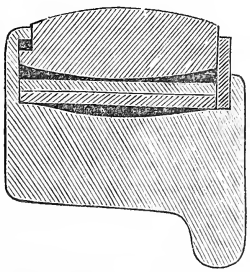
Revival of the Neanderthal Skull Controversy.—We had almost thought that everything that could be said upon the subject of the Neanderthal skull had been said *in extenso* already; but we were wrong. Mr. Carter Blake has opened the case again. In the last number of the *Anthropological Review* we find an article from his pen, in which he treats in a remarkably hazy manner of the views of other writers, and concludes by the expression of an opinion, the exact nature of which is by no means clear, but which seems to be a jumbled commixture of his own idea and the very peculiar speculations of Mr. William King.

Contemporaneity of Man and Ursus spelœus.—MM. Garrigou and Filhol consider that their recent inquiries have proved that man and the cave bear were contemporaries. This they believe is established by the discovery of bones which have been split along their length for the purpose of extracting the marrow: this habit was much in vogue among the first races of man, and is even still practised by such tribes as the Laplanders and Esquimaux. The aspect and form of the incisions are peculiar. When the section of the bone is of ancient date it presents the same coloration as the rest of the surface, and is frequently covered with the same matrix. When it has been produced in removing the bone from its place of deposit, the section has a far whiter and fresher colour than the general surface. The sections themselves have a wonderful uniformity in regard to the direction in which they have been made—they are almost invariably continued in a single right line. The heads of the long bones are always entire, the diaphysis being opened longitudinally, and attached in longer or shorter fragments to the heads. The short bones (vertebræ and phalanges) are usually found divided into two nearly equal parts.—Vide *Comptes Rendus*, May 16th.

Fossil Shells from Thibet.—A number of these have been sent over to Paris by M. T. Desmazures. They were discovered at a place called Kou-Chow, about twenty leagues south-west of Patang. They were observed in the pebbles forming the bed of the river, and which are employed by the natives in the cure of stomach diseases. M. Guyerdet, to whom they were sent for identification, has pronounced them to belong to the species of *Terebratula, T. cuboïdes, T. reticularis*, and *T. pugnus*.—Vide *Comptes Rendus*, May 9th.

MECHANICAL SCIENCE.

Elastic Railway Wheels.—A valuable paper on this subject was read by Mr. Vaughan Pendred at the Society of Engineers. After pointing out that repairs of way average in cost in Great Britain fifteen per cent. of the working expenses of railways, being in England 220*l.*, in Scotland 142*l.*, and in Ireland 84*l.* per mile, per annum, he stated that this enormous destruction was due to the percussive action of the wheels striking the rails on an extremely small base. To combat this wear and tear the tendency hitherto has been to render the permanent way as elastic as possible, the rails deflecting between the chairs, and the ballast giving way under the sleepers: hence the necessity for stirring the ballast as often as it is pounded into rigidity. On the other hand, Mr. Pendred contends that in making the permanent way the elastic member of the system, we throw on it a function for which it has no fitness, and that the wheel and wheel-tyre should be the true yielding parts. This he would secure by making the tyre independent of any rigid connection with the wheel. For this purpose steel hoop springs, made in segments, should be introduced between the wheel and tyre. This system, first introduced by Mr. Adams, has proved eminently successful in several trials; Staffordshire iron tyres elastically seated out-wearing steel tyres rigidly connected with the wheel on the ordinary plan. Now, the disintegration of rail and tyre proceeds *pari passu*, and the increased durability of the tyre is the measure of the lessened wear of the rail.



Section of Elastically Sealed Tyre.

Radial Axle Boxes.—Mr. Adams has also invented peculiarly-formed axle boxes, which allow a small amount of lateral play to the wheels of locomotive engines; so that in passing round curves the line of the wheel base adjusts itself to that of the rails, instead of being as heretofore rigidly straight. An engine so fitted has been running on the North London Railway, passing easily and steadily round curves of 132 feet radius.

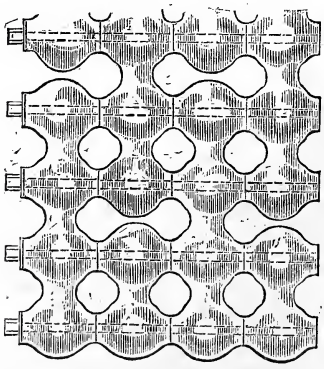
Steam Coals for the Navy.—Further official trials have been made at Keyham of the relative evaporative power of Welsh and North Country coals, which afford data valuable beyond the special question at issue. They show the *economic value*, or pounds of water evaporated per pound of fuel, to be for Welsh coal, taken from store, 9·34 lbs.; Welsh coal sent as sample, 9·90 lbs., and with specially shortened furnaces, 10·13 lbs.; for North Country coal from store, 8·26 lbs.; sent as sample, 8·41 lbs. When the furnace was improved by the addition of a perforated fire-door the evaporative power was 9·73 lbs. with the sample of Welsh coal, and 10·44 lbs. with the shortened furnace; 8·61 lbs. for North Country sample coal, and 10·23 with the shortened furnace. For mixtures of equal parts of Welsh and North Country coal obtained from store, 8·79 lbs.; of Welsh and North Country samples, 9·42 lbs.; and with shortened furnaces, 9·91 and 9·54 lbs. respectively. With perforated fire-doors the combination of Welsh and

North Country samples evaporated 9·45 lbs. It is remarkable that whilst alone the North Country still appears inferior to the Welsh, the mixture of the two has nearly as high an economic value as the pure Welsh, with greater rapidity of evaporation, and on the average less smoke.

Testing of Chain Cables.—An interesting paper on this subject was read by Mr. F. A. Paget, C.E., at the Society of Arts. The average tenacity of the bars of which the links are made is stated to be 24 tons per square inch; of this 28·75 per cent. is lost in the finished link, in consequence of (1) the geometrical form of the link, (2) the crushing stress undergone by the inside of the crowns, (3) the deterioration of the iron in bending, and (4) the loss of strength at the welds. As to the proper tests of the cable, Mr. Paget suggests the breaking of a portion by hydraulic pressure as affording the surest guide to the quality of the iron employed, testing the entire cable to a fixed proof strain, and finally, by blows or impacts, as specially adapted for the discovery of false welds. The apparent increase of strength of bars repeatedly broken, first exhibited in the experiments of Mr. Lloyd, is shown to be due to increase of hardness, or of the difficulty of the gliding to and fro of the particles, so that whilst the resistance to purely passive loads is increased, the resistance to impulsive forces is enormously diminished at each fracture. The value of the Government hydraulic test of 11·46 tons per square inch is discussed, and the permanent set under this strain is stated to be $\frac{1}{272}$ to $\frac{1}{15}$ of the length. While believing that a single application of this test does not materially injure the cable if good, Mr. Paget deprecates any attempt to make the test more severe.

Adheated Steam.—Mr. Waterman has patented a plan for making the sides of the cylinders of steam engines of extremely thin metal, and surrounding them by a jacket of steam of higher temperature than that working the engine. In this way, the losses from the condensation of steam in the cylinder during expansion and its re-evaporation into the condenser are avoided. The plan is a thorough carrying out of the principle of the ordinary steam jacket, right theoretically, but of doubtful practical advantage.

High Pressure Boilers.—Mr. Zerah Colburn has described to the Institute of Mechanical Engineers an entirely new steam boiler, adapted for very high pressures. It is the invention of Mr. Joseph Harrison, of Philadelphia, and consists of cast-iron spheres connected by hollow necks and secured by bolts. These spheres are 8 in. in external diam., $\frac{3}{8}$ in. thick and connected by necks of 3-in. opening, faced to a true surface to secure steam-tight joints. Experiments with this boiler in Belgium, at the request of the Minister of Public Works, proved that the boiler would not burst with a pressure of 1,440 lbs. per square inch. Similar experiments in this country showed that the spheres would successfully resist a pressure of 1,200 lbs. Ulti-



Small portion of a Harrison Boiler. Scale $\frac{1}{24}$th.

mately some spheres were burst at 1,650 lbs. per square inch, the safe working pressure of the boiler being therefore nearly 300 lbs. per square inch. One remarkable feature of this boiler is an entire freedom from corrosion and incrustation. As to its evaporative efficiency, experiments show an evaporation of 442·7 cubic feet of water by 38 cwt. of coal, or 6½ cubic feet of water per pound of fuel. Making allowance for the loss in heating the water, boiler, and brickwork at starting, Mr. Colburn estimates the average evaporation at 8 cubic feet of water per pound of fuel.

The "Great Eastern."—Dr. W. Fairbairn has made a report to some gentlemen interested in the great ship favourable to the removal of the paddle-engines as an expedient for reducing the cost of working. He estimates the money saved on three voyages per annum to Calcutta at £20,000, the speed being reduced from 14 to 10½ knots per hour. It is to be hoped, however, that means will be found to make this noble vessel answer commercially without the sacrifice of such distinctive features as the combination of paddles and screw and the resulting high speed at sea.

Armstrong and Whitworth Guns.—Nothing official has yet been made known as to the results of these trials, which have been prosecuted vigorously. It is reported, however, that whilst the Whitworth 12 Pr. gun exhibited great lateral accuracy, the deviation of 10 shots at 1,600 yards being only 5 inches, the vertical deviation was considerable, a wall 8½ feet high being hit directly only seven times out of fifteen. The Armstrong is said to have done better in this respect. Each 12 Pr. gun has now fired 2,500 rounds, or three times the number required to destroy the old brass field-piece. At 4,000 yards Mr. Whitworth has the advantage in range by 400 yards.

Institute of Naval Architects.—This association has held its session under the presidency of Sir J. Pakington with great success, iron-plated vessels of war affording the chief subject of discussion. Mr. E. J. Reed narrated a series of experiments confirming previous theoretical calculations, and proving that the centre of gravity of armour-plated ships is lower than that of the old wooden ships-of-the-line; and consequently, so far from being unsteady from top-weight, as has been alleged, they are more stable than the ships they replace. Mr. Cunningham described a mode of working heavy guns on shipboard by shafting connected with a steam-engine. The shafting has drums, round which a turn or two is taken by the slack rope of each of the ordinary gun tackles. When the slack of any rope is hauled on, it bites on the drum which accordingly works the gun, but when the end of the rope is let loose it slips. Captain Scott advocated wooden facing to armour-plates instead of backing, a plan which has been found to be successful when opposed to solid shot alone, but which is apparently open to the insuperable objection that the facing may be blown off in sheets by shell, leaving the iron exposed. Mr. J. Scott Russell read a paper on the present state of the questions at issue between modern guns and armour-plated vessels. The resistance of plates to shot he stated as follows: 4½-inch plates cannot be penetrated by cast-iron spherical shot from service guns; nor 5½-inch plates by 68lbs. steel shot; nor 6-inch plates by 9-inch steel shot. No plate has been found to resist the projectile of the 300-pounder. Mr. Barnes demonstrated a mode of ascer-

taining the longitudinal metacentre of a vessel, a problem which enables us to determine the effect of shifting the weights fore and aft on a vessel's trim. Mr. G. B. Airey, the Astronomer Royal, described a mode of steering or slewing a vessel by means of a screw-propeller, placed in the dead wood near the stern-post with its axis athwartships. Several papers were read on rudders and steering, amongst which may be mentioned that of Mr. Barnes, proving that for a given amount of power at the helm a small rudder, brought over to the full rudder angle, is more efficient than a larger rudder at a less angle. Also an account of some trials favourable to the use of a partially-balanced rudder, by Commander Shuldham, R.N. Admiral Sartorius advanced the claims of the steam-ram, whilst Sir E. Belcher, who sets a low value on the ram, from the difficulty of striking a ship in motion, proposed that war-vessels should be defended by an outer iron casing resting on longitudinal stringers, with an interior iron-cased cell of oval section containing the boilers and engines, the space between the outer and inner casing forming air-tight cells to be used as coal-bunkers. Mr. Norman Scott Russell discussed the relative advantages of turret and broadside arrangements of guns, arriving at the conclusion that the turret should only be used in moderate sized vessels, carrying one or at most two cupolas; in other cases, the broadside arrangement had a decided superiority. Mr. McLaine advocated a system in which the guns fire only in the line of the keel, the vessel having twin screws, so that the lateral training of the guns is effected solely by steering, the ship always fighting bow on. Capt. Symonds introduced the subject of twin-screw vessels. Mr. E. A. Cowper read a paper on uniform power expansive marine engines, in which the use of the steam jacket is extended, and a reservoir provided to receive the steam from the high-pressure cylinder until, the cranks having passed round 90, the low-pressure cylinder is ready to receive it. Among several remarkable papers by Dr. Rankine, the most practically interesting was one on the computation of the resistance of proposed ships, from which the speed with a given engine power and the engine power necessary for a given speed may be ascertained.

Experiments on Armour Plates.—Further experiments at Shoeburyness confirm the high opinion already formed of the Chalmers system of armour-plating. The target consisted of a facing of $3\frac{3}{4}$-inch plates, backed by 10 inches of teak and an inner casing of $1\frac{1}{4}$-inch plates connected with the facing by $\frac{3}{8}$-inch iron webs between each balk of interposed timber. The inner plating rests on five inches of teak, and this again on the skin of the vessel $\frac{5}{8}$-inch thick. It proved entirely invulnerable to all service projectiles, but was pierced by the 300-pounder.

Palliser's Bolts.—Captain Palliser has introduced a singularly scientific improvement of the bolts for armour-plates, which overcomes the grave difficulties in their attachment to the ship hitherto existing. He causes the bolt to be turned down throughout its length to the diameter of the metal at the bottom of the screw-threads. Hence the strain on the impact of a shot, being equally intense throughout its entire length, the bolt elongates, acting as a perfect cushion or spring, instead of chipping off immediately below the nut.

MEDICAL SCIENCE.

Structure of the Nerve-cells in the Frog.—Perhaps one of the most interesting and exquisitely illustrated memoirs that has ever been presented to the Royal Society is that of Dr. Lionel Beale on the above subject. In order to thoroughly grasp the difficulties of this branch of microscopic anatomy, the reader must refer to the monograph itself, which has been published separately; but by reference to the accompanying plate (Pl. XXI.), the following conclusions which the author has reached will be rendered explicit:—

(1) In all cases nerve-cells are connected with nerve-fibres, and the cell probably influences only the fibres with which it is structurally continuous. (2) Apolar and unipolar cells have no existence, all nerve-cells having two fibres in connection with them. (3) In certain ganglia of the frog there are large pear-shaped cells, from which two fibres proceed—*a*, a straight fibre continuous with the central part of the body of the cell; and *b*, a fibre or fibres connected with the circumferential part, and coiled spirally round the straight fibres. (4) These two fibres, after lying very near to, and in some cases, when the spiral is very lax, nearly parallel with each other, at length pass toward the periphery in opposite directions. (5) Ganglion cells exhibit different characters, according to their age. In the youngest cells, neither of the fibres exhibits the spiral arrangement; in fully-formed cells there is a considerable extent of spiral fibre; but in old cells the number of coils is much greater. (6) These ganglion cells may be formed in one of three ways: *a*, from a granular mass like that which forms the early condition of all structures; *b*, by the division or splitting up of a mass, like a single ganglion-cell, but before the mass has assumed the perfect form; *c*, by changes occurring in what appears to be the nucleus of a nerve-fibre. (7) During the development of a ganglion cell, there is reason to believe that the entire cell moves away from the point where its formation commenced, so that the fibres connected with it will become elongated. (8) There are nuclei in the body of the cell; and there are nuclei connected with the spiral and also with the straight fibre, the nuclei of the cell being found both on its surface and in its substance. (9) The matter of which the nucleus is composed has been termed (by Dr. Beale) germinal matter. From it alone growth takes place, and in all cases the matter of which the nerve fibre consists was once in the state of germinal matter. (10) The nucleolus also consists of germinal or developing material. (11) The ganglion cells are connected with both dark-bordered fibres and fine ones. (12) Contrary to Kölliker's statement, there are neither *apolar* nor *unipolar* cells in the ganglia of the heart. (13) The muscular coat of the arteries is supplied with nerve-fibres. (14) The connective-tissue-corpuscles are quite distinct from the nerve-fibres. (15) The so-called nucleated capsule of the ganglion-cells in the ganglia of mammalia usually consists of nerve-fibres. (16) As nerve-fibres grow old, the soluble matters are absorbed, leaving a fibrous material which is known as connective-tissue.

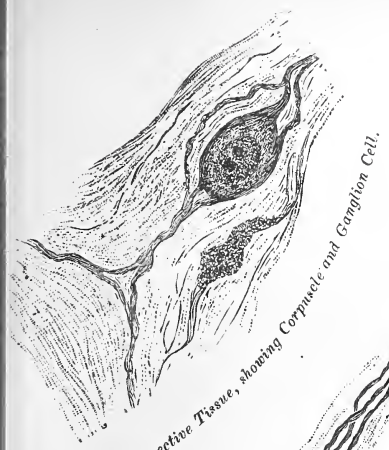
No one can help admiring the beauty of Dr. Beale's drawings, and admitting the accuracy of most of his conclusions. In some cases, how-

ever, we think his theories are hardly as well supported as they ought to be. For example, we do not see why—admitting the connective-tissue corpuscle to be a non-nervous tissue—it is necessary to assume that the insoluble material left represents connective-tissue. Such a conclusion would imply, either that connective-tissue was *formed* nervous matter, or that it had the power of being developed in two distinct ways.

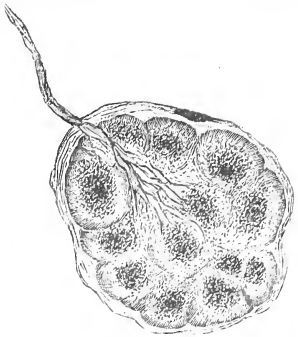
The Development of Fibrine.—The production of the material known as fibrine is due to that gradual death of minute particles of the living matter, of the white and small colourless corpuscles, which takes place under ordinary circumstances when blood escapes from the vessels of the living body. The blood does not die the very instant it leaves the vessels, and, as is well known, it may be caused to retain its vitality much longer under some conditions than others. It is even probable that these particles of living matter may absorb nutrient matter, and increase for some time after the blood has left the vessel, so that it is possible, not only that some of the fibrine, but that the living matter from which it resulted, may have been produced after the blood was removed from the organism. A white corpuscle will *live and move* for hours after the blood has been drawn from the body. Such is the ingenious theory which Dr. Beale advances to explain the origin of fibrine, and certes it must be said that it is a most rational one.—Vide *The Quarterly Journal of Microscopical Science*, April, 1864.

Epilepsy accompanied by Diabetes.—In the last number of the *Archives of Medicine* will be found a report of a very instructive and singular case of this kind which occurred in the practice of Dr. B. Sequard. Mr. Lockhart Clarke, who examined the condition of the spinal and cerebral organs, reports that the "point of the *calamus scriptorius* was composed entirely of a column of densely-crowded oil globules; and a similar degeneration, though in a less degree, extended to the corresponding parts, a little below as well as a little above, where it partly affected the nuclei of the pneumogastric nerves."

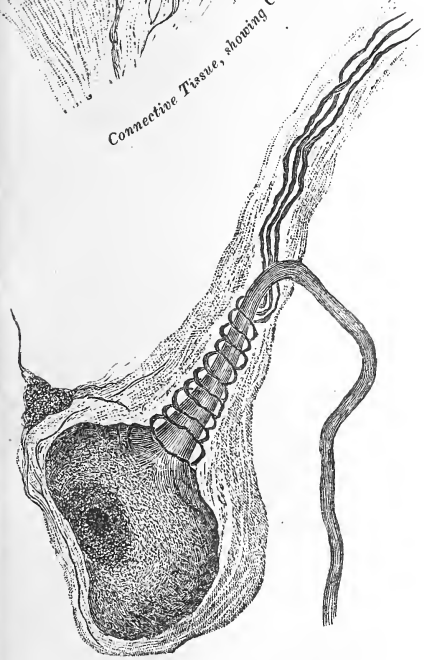
Nature of Skin Parasites.—A little pamphlet has recently been published in which Dr. Tilbury Fox comments severely upon the hypotheses of Mr. Erasmus Wilson. The latter gentleman has broached the idea that the so-called plant parasites of the human skin are not vegetable growths at all, but are merely the ordinary epidermoïd tissue which has undergone some species of metamorphosis. This doctrine is opposed, and we think justly, by the former, who advances many arguments in favour of the vegetal character of the organisms in question, and shows—1st. That we are able to distinguish the presence of cellulose externally, and internally the primordial utricle coloured by iodine; also that the tubed mycelial form and fructification are present, and thus exhibit truly vegetal features. 2nd. That ether, chloroform, and spirit of wine, which render epithelial tissues transparent (?) and dissolve fatty substances, do not affect the parasitic structures. 3rd. When the parasitic structure is removed from the skin, "put up," and kept in a warm place, it will be observed to grow. The nuclear will develop into the sporular form, and the sporules will join together and increase in size, bud, or produce mycelium. These phenomena have been observed by Dr. Fox in a specimen of tricophyton which had been removed from diseased hair. Dr. Fox's



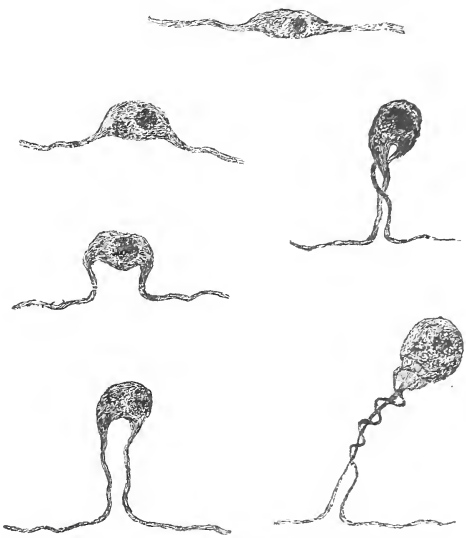
Connective Tissue, showing Corpuscle and Ganglion Cell.



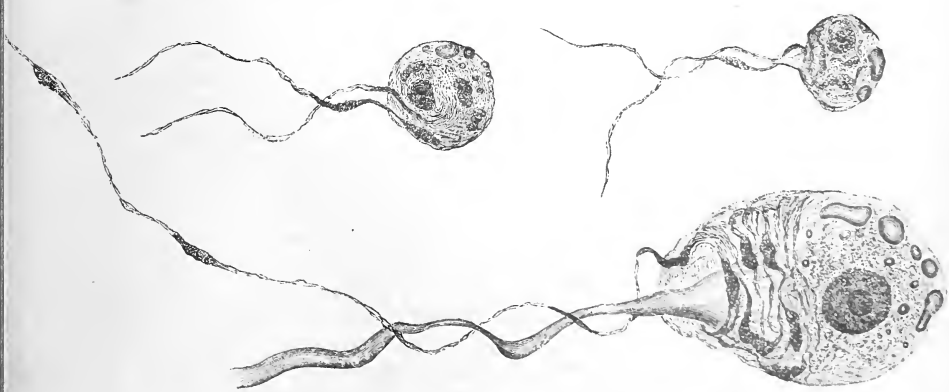
Ganglion Cell undergoing division



Ganglion Cell, showing Straight and Spiral Fibres.



Drawings illustrating the conversion of Nerve-nucleus into Ganglion Cell, with Straight and Spiral Fibres.



Three Cells of different ages from the same Ganglion.

STRUCTURE OF NERVE-ENDS.

conclusions are very valuable, and, as they bear upon the entire pathology and treatment of this class of diseases, they should be known to all physicians.

Development of the Maxillary Bones.—Mr. Hulme has compiled a useful essay upon this subject, in which to his own inquiries he unites those of Rathke, Reichert, Coste, Leidy, Robin, and others. He thinks that it is evident that each superior maxillary bone in man is derived from two distinct centres of development. One of these produces that portion of the bone which corresponds to the superior maxillary bone of the lower mammalia, and the other to that portion of the jaw which contains the incisor teeth and corresponds to the intermaxillary bone of the same animals. The development of the lower jaw proceeds more rapidly than that of the upper, for, while it is not until the thirtieth or thirty-fifth day that we find indications of the four buds or processes from which the superior jaw-bones are developed, the buds which constitute the lower jaw have grown out and united in the median line as early as the twenty-fifth or twenty-eighth day.—Vide *Dental Review*, April, 1864.

Bony Tumour in the Eyelid.—In that excellent periodical the *Ophthalmic Review*, we find the following case reported from Von Gräfe's Journal. A patient presented an enlargement of the upper lid, and on everting this a circumscribed tumour of somewhat oval form and as large as half a hazel-nut emerged from the palpebral sinus, not far from the outer angle. It was hard and covered with smooth conjunctiva. It was drawn forward with the forceps, and excised and examined by Dr. Schweigger, who found under the normal conjunctiva a very dense cellular tissue, and then a nucleus of true bone, somewhat resembling in form an incisor tooth, and measuring almost three lines in its longest diameter.

Fatty Degeneration of the Blood.—Under this title a new disease has been described by Signor Tigri, who finds that the circulating fluid occasionally undergoes a peculiar alteration, which results from the accumulation of a fatty substance in the red corpuscles. This phenomenon, which was at first observed only in extravasated blood, has now been detected in the fluid traversing the vessels. Signor Tigri is of opinion that this discovery will help to explain the nature of certain cases of death in which no apparent alteration of the organs indispensable to life has been observed. —Vide *Comptes Rendus*, April 18th.

Micro-photographs.— M. Duchenne, of Boulogne, has succeeded in obtaining some very beautiful photographs of the microscopic appearances of various portions of the spinal-cord of man. The specimens represent transverse sections of the marrow in the normal and pathologic conditions, and indicate magnifying powers of from 200 to 1,000 diameters. If these representations are sufficiently distinct to admit of their being transferred to stone and then printed, the benefit to science will be very great. By such means, if generally adopted, a good deal of unpleasant controversy would be avoided.

Cause of the Falsetto Voice.—According to the researches of M. Fournié the falsetto voice is produced by the following alterations of the vocal cords: the two posterior thirds are kept in close contact by the action of the inferior and middle constrictors of the pharynx and by the contraction

of the lateral fasciculi of the thyro-arytenoïd muscle. That this condition is the true one was proved by the production of falsetto notes by an artificial larynx which had been arranged in the manner indicated above.—Vide *Comptes Rendus*, April 11th.

Influence of the Spinal Nerves over the Action of the Heart.—Several interesting though cruel experiments have lately been carried out on dogs, by M. Schiff, with the object of determining the extent of this influence. The animal is placed upon its back and kept in that position, and then two long and sharp needles are taken by the operator and plunged into the body: one of them is driven in beside the sternum till it reaches the point of the heart, without wounding it; the other is forced into the diaphragm. These two needles by their separate vibrations indicate respectively the movements of the circulatory and respiratory organs. When, under these conditions, the experimenter irritates any of the sensitive nerves of the head, as the anterior auricular or suborbital nerves, the movements of the heart slacken, often to as few as *four* pulsations in the minute. If now the operator ceases to irritate the sensitive nerves, the action of the heart commences again. M. Schiff details the results of no less than eight different experiments made in this way, and terminates his memoir with this conclusion: in the spinal nerves the roots which operate upon the heart and larynx are by no means the same, for their filaments arise from distinct portions of the medulla, those presiding over movement arising more posteriorly than the others. The influence of the medulla oblongata upon the heart is not due to filaments which spring from the bulb properly so called, but to those which, in the interior of the medullary substance, descend towards the spinal marrow of the neck, and leave this centre with the cervical roots of the spinal nerves.

Condition of the Blood in Inflammation.—MM. Estor and Saint-Pierre affirm that the red colour of an inflamed part is due to the following circumstances:—(1) That the venous blood of the part contains a larger quantity of colouring matter than usual; (2) that it contains a greater proportion of oxygen than that of the healthy part, for whilst that of the latter is represented by 1, that of the former rises to 1·50, and even to 2·50; (3) that the venous blood, during inflammation, contains a greater quantity of carbonic acid; and (4) an increase of red colour is always consequent on an increase of oxygen.—Vide *Comptes Rendus*, April 4th.

Expulsion of Carbonic Acid from the Blood.—In one of the late numbers of the Proceedings of the Academy of Sciences of Vienna, a most interesting communication from Dr. Ludwig appears. In this paper the author demonstrates, by reference to the results of numerous experiments, that the removal of the carbonic acid is not due to any action of the tissue of the lungs, but simply results from the action of the oxygen. When blood was agitated with oxygen it was found to have lost its carbonic acid, and to have become to all intents and purposes arterial blood. To determine whether the evolution of carbonic acid is effected directly by the oxygen, or only by the intervention of the blood-corpuscles, the purest possible serum which, as is well known, contains much carbonic acid, was employed, and, for the sake of comparison, both unaltered serum and such as had been agitated with oxygen. In these experi-

ments the same quantity of combined carbonic acid was found in every case, and consequently only that portion of the oxygen which has passed into the corpuscles acts in the evolution of carbonic acid. Another series of experiments proved that, though arterial blood could be easily prepared by artificial means from venous, the latter could not be prepared from the former. Hence it would appear that carbonic acid is furnished in the combined form by the tissues.

The Movements of the Heart.—An active controversy took place not long ago in the Imperial Academy of Medicine upon the subject of the movements of the various portions of the heart. MM. Chauveau and Marey represented one side, and the other was taken by M. Beau. The former physiologists assert :—

1st. As held by Harvey and Haller, the impulse of the heart against the thorax is essentially a systolic movement, and is due to the contraction of the ventricles.

2nd. Immediately after the ventricular systole, the walls of the ventricles widen and relax, and the blood which was contained till then in the auricles, falls by gravity alone into the ventricular cavity; in this way the ventricular diastole begins, it is *only completed* by the after contraction of the auricles.

3rd. The instant the auricular systole is over, the walls of the auricles relax, yield to the pressure of the blood contained in the great veins, and the auricular diastole commences just as the ventricular systole is occurring.

To these assertions M. Beau makes the following replies :—

1st. The impulse of the heart is a *diastolic* phenomenon, and is due to the diastole of the ventricles.

2nd. The diastole of the ventricles takes place during, and is caused by, the contraction of the auricles. Until the auricles contract, not a drop of blood passes from the auricular into the corresponding ventricular cavity.

3rd. The diastole of the auricles does not commence till after the systole of the ventricles.

It seems to us there is a great deal more of allegation than true evidence in M. Beau's remarks, and we certainly do not feel inclined to accept his statements in opposition to the conclusions (drawn from experiment) arrived at by Professor Dalton, of the United States, who has already done so much to elucidate this department of human physiology.—Vide *L' Union Médicale*, May 17th.

Medical Prize Essays.—The "Society of Medicine," of Gand, announces the following as some of the subjects on which essays are to be presented in 1865 :—(1) A description of the diseases which may result from employment in linen and cotton factories. (2) Rheumatism and the rheumatic diathesis. (3) Diseases which result from parasites, and parasites which result from diseases. (4) The influence of the syphilitic diathesis on the production of internal diseases. (5) The value of studying the anatomical lessons presented by post-mortem examinations of the insane. (6) The therapeutic effects produced by the compression of aneurisms. (7) The action of alkalies in the treatment of diseases. The essays must be

written legibly in French, Flemish, or Latin, and addressed, post-paid, to Dr. E. Lesseliers, rue Basse, 23, à Gand.

Statistics of Suicide.—M. Legoyt, who has written a very extensive work on this subject, is of opinion (1) that suicides increase more rapidly than either the population or general mortality in all the following countries :—Bavaria, Hanover, France, Mecklenburg, Prussia, the kingdom of Saxony, and Sweden. (2) Contrary to the usual opinion, *England ranks lowest in the scale, as regards frequency of suicides.* Denmark and North Germany stand highest, and France occupies a middle position. (3) There are generally about thirty suicides of women to a hundred of male suicides. (4) The number increases with age up to about sixty or seventy years. (5) The number is smallest in January and greatest in July. (6) Women are more influenced by moral agencies, men by material ones. (7) Among married persons the number of suicides is smallest; it is larger among the unmarried, and attains its greatest limit among those who have been separated or divorced. (8) In Prussia it has been calculated, that of every million of inhabitants the Protestants give 153 suicides, the Jews 51, and the Catholics only 47. (9) Suicides are far more frequent in large towns than in other portions of the country. Of all the conclusions deducible from the foregoing statistical account, the most astounding one is, that suicide is generally and rapidly increasing; and this the author supposes to be due to the natural consequences of the intensely civilized (?) condition into which we are passing.—Vide *L' Union Médicale*, May 12th.

New Instrument for Teaching Students the Sounds of the Heart.—This peculiar machine, invented by Dr. Collongues, has been described by M. Velpeau. It consists of a hollow bust of plaster of Paris, on whose anterior surface are placed ten openings, and whose posterior surface possesses two apertures—each opening having attached to it a label bearing the name of a "bruit." To these foramina several india-rubber tubes pass. Air is made to travel along the tubes, and according to the pressure exerted and the calibre of the tube the special sound is developed. We doubt very much that Dr. Collongues' invention will be found of great practical utility.—Vide *Comptes Rendus*, April 25th.

The Heart's Recoil.—Mr. Hiffelsheim would have us believe that at each moment when the ventricles contract and drive the blood into the arteries, the double jet of liquid thus produced necessarily determines a movement of the heart itself in the opposite direction to that assumed by the currents. The return of the organ to its proper position prior to each pulsation, is simply the result of the reaction of the adjacent elastic structures. He has been unable to ascertain how this recoil influences the other movements of the heart, but hopes to do so on some future occasion.—Vide *Comptes Rendus*, May 9th.

Increased Secretion of Urea in Bright's Disease, brought about by the Action of Electricity.—There can be little doubt that electricity is now becoming an extremely important therapeutic agent in the hands of those who understand how to use it. M. Namias tried its effects in a case of Bright's disease of the kidney, and as he states, with the most beneficial results. He applied the electricity for about half an hour each day, directing the current through the loins, and he found after forty-eight hours that not only was the

quantity of urine secreted greater than before, but the per centage of urea was also larger, having been increased from 2·29 per cent. to 2·80. We confess we have not been startled by M. Namias' achievement, and from the circumstance that the increased secretion of the urea was accompanied by an increased proportion of albumen, we question the expediency of employing electrical agents as means of cure in such cases. If the gland be really disorganized, all the batteries in the world would be unavailing.—Vide *Comptes Rendus*, lviii. No. 19.

METALLURGY AND MINING.

A New Form of Amalgamator has been proposed by Mr. Farrand, of San Francisco. It consists of a trough-shaped machine of wood or iron, with dies to fit upon its inner surface. The mullers are attached to a rocking shaft, and are moved backwards and forwards instead of in a circular direction. The dies are a parallelogram in shape, with grooves or recesses for the quicksilver, in which it is gently agitated with stirrers. The machine is reported to act very well, and is expected to give rise to important results.—Vide *Mining and Smelting Magazine*, May, 1864.

Chrome Pig Iron.—Some specimens of this compound were exhibited at the last meeting of the Austrian Engineers' Association, by Herr Friese, who had obtained them from some experimental charges of chrome clay iron-stone, at the St. Stephan iron works. The iron has a white, almost lustrous fracture, and is very brittle, for which reasons the ores, notwithstanding their high per centage, have been hitherto considered to be useless. Accurate analyses of the ore and iron have not yet been made, but it may not be impossible, with proper treatment, to obtain useful pig iron from them. At the same meeting Herr Friese exhibited some samples of blasting powder, which, besides being cheaper, is considerably more effective than the ordinary blasting powder. The inventor calls it "non-explosive blasting powder," or alcaloxide. So far as was observed it seemed to burn very slowly, but its properties have not yet been fully investigated.

A New Mining Journal.—We understand that a new periodical to be devoted to mining interests is about to be started at New York. It is to be called *The American Coal Trade Review*. It will be published weekly, and besides reliable statistics regarding the mining and shipping of coal throughout the United States, it will contain occasional historical and scientific articles upon the subject of coal, and its bearings on the commercial and manufacturing prosperity of that country. A new monthly has also been issued, bearing the title of the *American Mining Gazette and Geological Magazine*.

Petroleum as a Substitute for Coal.—The commission appointed by the American Government to inquire into the relative evaporative powers of petroleum oil as compared with anthracite coal, the practicability of its use, if unattended with danger, and its advantages, if any, have issued their report. The commission was composed of three chief engineers, and their experiments extended over a period of five months. As regards evaporation the reply was, that it is 10⅝° higher in power than anthracite coal, while the time required for generating steam to 20 lbs. pressure was 28 minutes as compared with 60. The commissioners accordingly recom-

mended the Secretary of the Navy to introduce the oil on board one of the Government steamers to determine accurately its economical efficiency. As the rapidity of evaporation does not always correspond proportionally with the quantity of water evaporated by each pound of coal, it would be interesting to know the number of pounds or gallons of water evaporated by each gallon of petroleum, and the additional danger, compared with coal, attending its use, because many of the great steam-boat accidents on the American rivers have been traceable to the careless use of turpentine (a less explosive material) for the same purpose. The advocates for the introduction of petroleum as a substitute for coal contend that, in a vessel like the Cunard steamer *Persia*, the saving, taking into account the smaller space required, and all other advantages, would amount to £2,400 for each trip. Experiments on a larger scale will, it is said, speedily be made in an ocean steamer, by a company, to whom the present trustees are about to transfer their rights. In addition to the discovery of considerable deposits of the oil in Southern Russia, large quantities are alleged to have been found on the Pacific in California. The calculations as to economy, however, seem to have been based upon the assumption that the price would remain as now, after the increase of demand, and also upon the cost of coal in America and not in England. It is alleged that its use will be a great saving not only for merchant steamers, but that a naval steamer using it can keep the sea under steam three times as long, and with less labour and greater economy as compared with an equal weight of coal.—Vide *Mining and Smelting Magazine*, Vol. v. No. 29.

A New Coal Mine has recently been discovered near La Paz, in California. This discovery must necessarily be of great value to the Colerado copper mines, which have been rather imperfectly worked of late, owing to the great scarcity of fuel.

Imports of the Metals.—From the reports of the Board of Trade for the two months, ended on the 29th of February last, we perceive that with the exception of brimstone, copper-regulus, tin, and pyrites, there has been a decided increase in the quantity of mineral matter imported this year over that of last year.

Improved Cast-Iron.—It has recently been demonstrated that cast-iron composed of old and new metals in certain proportions, calculated to give it a great power of resistance, acquires a new degree of strength by an addition of 2 per cent. of wolfram or tungsten. In one of the combinations thus made, the increase of the power of resistance to fracture per square centimetre, was 44 kilogrammes with French wolfram. In another, formed of one-third of old English cast-iron, and two-thirds of old ordnance, the increase, with German wolfram, was 67 kilogrammes per square centimetre. M. Leguen has just shown that, when subjected to a second fusion, cast-iron containing wolfram is still superior to other cast-iron similarly treated. After this operation, the difference of resistance in favour of the former was 26 kilogrammes per square centimetre; and German wolfram is superior to French, even after a second fusion. A third fusion of the same cast-iron having been directly effected in a Wilkinson's furnace, instead of being done in a crucible as in the preceding cases, the tenacity of wolframed cast-iron was again greater than that of the common sort treated in the same manner. Hence it may be concluded

that the action of wolfram subsists even when the fusion is effected directly in a furnace, and remains after several successive fusions. The wolframed cast-iron mentioned above, containing fragments of old ordnance, seemed to become stronger at every successive fusion. Another proof of the superiority of wolframed cast-iron over the common sort, is that bars made out of the former do not bend so much as the others, under the action of equal weights, whence it may be inferred that the wolframed sort is more elastic and more capable of resistance. In all cases, therefore, in which it is required to have cast-iron offering great resistance to fracture, the addition of a small quantity of wolfram offers an easy means of obtaining it.—Vide *The Artizan*, June, 1864.

Crystallized Iron.—This peculiar form of the metal is the production of a mine belonging to the New Jersey Zinc Company. There is but one mine of this ore in the world. The zinc having been just extracted from the ore, the residue is the brilliant and singular metal termed *crystallized iron*. For many years no use was made of this mineral, and it was simply exhibited in cabinets as a curiosity. However, a use has at last been found for it, and since it has proved so superior in this instance, many other avenues for its introduction are now opening; and it bids fair to prove not only one of the most remarkable but one of the most useful and valuable metals the world has ever known. As a preventative against drilling, when combined with wrought iron and steel, it is the only real protection against the burglar. Owing to the late improvements in hardening drills, chilled iron can be easily bored. Hardened steel is not only so brittle as to be almost useless, but its temper can be drawn by a blow-pipe, and then it is at the mercy of the burglar's tools. With the crystallized iron the case is different; it can be furnished of any thickness, is not so brittle as any other hard metal, cannot be affected by a blow-pipe, and is the hardest material to bore through ever yet produced.

Faulkner's Electric Pit Signals are so contrived as to render them invaluable as a means of safety to miners. For example, if a ventilating door, which ought to be shut, is by neglect left open, the signal is so constructed, that it will ring with a tremendous noise till the door is closed. On the other hand, if a door is closed which ought to be open, the bell will ring also. If the door be open only the sixteenth of an inch, it will set the bell ringing as loudly as if it were wide open. In order to show from what part of the mine a signal proceeds, a box or partition may be fixed in some conspicuous place, with a number-plate and number for each part of the pit which it may be thought desirable to indicate. These number-plates are fixed by hinges, so as to move in or out, and the electric wire is fixed to each number-plate corresponding with that part of the mine which it represents. Thus, when a signal is rung, the number of the part from which it comes is projected outwards. This invention, in fact, may be used for any purpose of warning, calling, or signalling in the pit, and it is to be observed that when any signal is touched, it can be distinctly heard all over the mine.—Vide *The Artizan*, May, 1864.

METEOROLOGY.

Rotation of the Upper Currents of the Atmosphere.—M. Elie de Beaumont has published a letter on the above subject. The communication

was from M. Poey, the well-known meteorologist. He considers that many years' experience has enabled him to prove the accuracy of Herr Dove's laws. His observations have been especially made upon clouds, and from their peculiar movements he concludes :—

1st. That when in the northern hemisphere the currents of air proceeding from the equator alternate with the polar ones, the wind appears to come from every point of the compass, and usually in the following order : south, west, north, east, and south.

2nd. Upon the southern hemisphere the opposite is the case, the order of occurrence being : south, east, north, west, and south.

3rd. The influence of the wind on meteorological phenomena combined with the law of its change may be said to represent two distinct sections of the compass—east and west.

Peculiar Form of Hailstones.—At the sitting of the French Academy on the 4th of April last, M. J. A. Barral reported some interesting meteorological facts observed in Paris on the 29th of March last. There had been snow and rain from eight in the morning till ten, and then from that till noon it rained and hailed, there was thunder at one, and at three P.M. a very singular form of hail fell in heavy showers, different from what has heretofore been described by natural philosophers. Ordinary hail-stones are generally flattened or round, and frequently more or less angular, and present concentric layers surrounding a nucleus. That which fell on the 29th of March was of a very different character. The stones were quite conical in form, being slightly concave at the base ; the surfaces were covered over with little projecting six-sided pyramids of a transparent character, and a few of a similar form were observed in the concave portion of the base. They were about eight or ten millimetres wide, and from ten to thirteen millimetres in length. They weighed, in various instances, from 180 to 250 milligrammes, and seemed to be formed by the adhesion of several minute pyramids, leaving a cavity in the centre. They fell point downwards.—Vide *Comptes Rendus*, April 4th.

MICROSCOPY.

With the exception of an improved form of mounting-table, which has been described by Mr. Goddard in the last number of the *Microscopical Journal*, very little has been done in the way of manufacture of new varieties of instruments. This is most probably due to the circumstance that the Council of the Microscopical Society of London propose to give medals for the best forms of instruments submitted to them. They offer a medal for the best specimen presented in each of the following classes :—

1. An educational microscope, to be sold for ... 3 guineas.
2. A student's microscope „ „ ... 5 „
3. A student's binocular microscope „ ... 10 „

Also a certificate of excellence for a hand microscope, to be sold for one guinea.

Notices of papers on subjects of interest to microscopists will be found under the following heads :—

Botanical Section—
- Raphides as Characters of Plants.
- Cryptogams in Eggs.
- Chinese Diatomaceæ.

Geological Section—
- Exogenous Wood in arenaceous Limestone.
- Minute Geologic Evidence.

Medical Section—
- Structure of Nerve Cells in the Frog.
- The Development of Fibrine.
- Epilepsy accompanied by Diabetes.
- Nature of Skin Parasites.
- Fatty Degeneration of the Blood.
- Micro-photographs.

Zoological Section—
- Tubularia not Parthenogenous.
- British Polyzoa.
- Zoosperms in the Ovary of the Snail (?)
- Sphærularia Bombi.

MINERALOGY.

Characters of Tephroite.—The characters of this mineral have hitherto been but questionably known, for no effort has been made to distinguish the substance from its congeners. Professor G. J. Brush, of Yale College, U.S., has therefore done good service in publishing the results of his observations. According to this mineralogist, the optical and crystallographic characters of tephroite are now clear enough, being similar to those of chrysolite; this isomorphism being further sustained by the chemical composition of the two minerals. Before the blowpipe tephroite fuses easily to a black mass, fusibility equal 3·5 on Von Kobell's scale. With the fluxes it gives reaction for silica, manganese, and iron. On charcoal, most specimens give traces of zinc due to the mechanical mixture with zincite. Heated in the closed tube it gives traces of moisture. Hydrochloric acid dissolves it, without an evolution of chlorine, and on heating the solution a perfect jelly is formed. It is composed of silica, oxides of iron, zinc, and manganese, with small proportions of lime and magnesia. Its analyses show that it is to be regarded as a *manganesian chrysolite.*—*Silliman's American Journal*, vol. xxxvii. p. 68.

A new Zeolitic Mineral has been found by Professor How in the trap rocks of Nova Scotia, and has been designated *Mordenite* by its discoverer. It occurs in rather small masses, in the form of somewhat cylindrical, reniform, or flattened geodes and solid concretions, rather smooth externally, sometimes covered with a thin yellowish crust, blotched with a green mineral (probably a silicate of iron), and at others, exposing its own yellowish white or pinkish-coloured surface. Its interior frequently presents hardly any trace of crystallization, but on close examination a

fibrous structure is seen, which in some cases is so distinct that the mineral has probably been considered to be a compact variety of *Thomsonite*. It has a highly silky lustre, weathering dull; it cleaves readily in the direction of its fibres, and is translucent on the edges. Its hardness is represented by 5; it is rather brittle, and has a specific gravity of 2·08. It has the following chemical composition :—

Soda	2·35
Lime	3·46
Alumina	12·77
Silica	68·40
Water	13·02
	100·00

On comparing it with minerals containing the same elements, it is found to be nearest to *heulandite* in chemical composition; and Professor How considers it to be the most highly silicated of the aluminous non-magnesian hydrous silicates yet described.—Vide *Mining and Smelting Magazine*, No. 28.

A new Steatitic Mineral.—A peculiar mineral of a green colour, and having a sort of prismatic structure, was found some time since in the lead-mining district of the County Dublin. Mr. Ormsby, to whom is due the merit of the discovery, gives the following description of it :—Its specific gravity is 2·738; it scratches gypsum slightly, and is deeply cut by calcite, so that its hardness is a little above 2°. It is unctuous to the touch, although the analysis gives but a very slight percentage of magnesia. When held in the forceps before the blowpipe, it glows brightly, becomes white, and slightly fuses on the edge; it dissolves in borax, and leaves a siliceous skeleton; the bead is colourless when cold but greenish when hot, showing the presence of iron; no manganese could be detected even with the nitre test. The substances entering into its composition are silica, alumina, iron, potass, soda, lime, magnesia, lithia, and water.—Vide *Dublin Quarterly Journal of Science*, April, 1864.

Presence of Thallium in Lepidolite.—It has been announced by Professor Schrötter, in a communication to the Vienna Academy of Sciences, that thallium has been found by him in both lepidolite and mica. It is not necessary to use a large quantity of the material in order to detect the presence of this metal. His method of procedure is this :—Taking the mixture of the double chlorides of platinum with the potassium cæsium, rubidium, and thallium, obtained from the above sources, he removes the potassium, and then reduces the other chlorides in a stream of hydrogen at a low temperature. Next he treats the well-washed, spongy mass of platinum with sulphuric acid, and by the repeated washing-out of this, obtains a solution which shows the characteristic reactions of thallium. Mr. Crookes, however, is inclined to doubt the accuracy of Professor Schrötter's process, and appears inclined to attribute the results obtained by the latter chemist to the circumstance that in sulphuric acid—the liquid employed—thallium is frequently found.—Vide *Journal für Prakt Chem.*, I., 1864, and *Chemical News*, No. 227.

PHOTOGRAPHY.

The supposed early Photographs.—The startling claims advanced in support of these photographs have melted into thin air. Based as they were on mere rumours and conjectures, little else indeed could have been expected; and yet how many were the uplifted hands and wondering eyes, and how loud the exclamations with which such claims were at first received! The impressions on metal appear to be comparatively modern productions by the process of Daguerre, and it is more than suspected that the paper pictures were produced by some clumsy, half-mechanical, half-secret process called in its day the Polygraphic, which merely printed outlines previously made by an artist to be afterwards filled in by hand. The Mr. Price, too, whose statements originated all this fuss, has been proved quite unworthy of belief; and has, moreover, absconded to escape the unpleasant results of an imperfect appreciation of "*meum et tuum*," and the search of the detective police; while in consequence of the abstracted papers containing certain family secrets, the angry representative of Matthew Boulton—to whose statements we owe our last piece of information concerning Mr. Price—heaps unsparing abuse on the head of Mr. Smith for his undue enthusiasm in the cause of scientific discovery. *Sic transit gloria mundi!*

A New Carbon Process.—As it was, so it is. The fond dream of photographers has been for many years the obtaining of a perfected carbon process; and yet when in 1860 M. Fargier patented a process in France by which the most exquisitely beautiful carbon prints are obtainable, it was suffered to rest in cold obscurity, reminding us of the old alchemists, who were always seeking new scientific facts, yet when they discovered the grand first principle of photographic art, could find no better use for it than that of printing photographic labels for bottles! But our modern photographers are, after all, not quite so blind; for within the last month or two the photographic world has been in a ferment of excitement concerning a new carbon process, the invention of Mr. Joseph Swan, an amateur photographer residing in Newcastle-on-Tyne, whose process was first described in a paper read before the Photographic Society at King's College on the 5th of April last.

Mr. Swan's process is somewhat easier in practice than that of M. Fargier, and produces results equally beautiful and perfect; but we think he will have some difficulty in establishing his claim to the patents which he has already secured in Great Britain and Ireland, France, Belgium, Spain, Prussia, Austria, and America, should any one be bold enough to infringe the same. The process may be thus briefly described:—A mixture is made containing one part of a solution of bichromate of ammonia in three parts of water, and to this is added another mixture consisting of two parts of gelatine, one part of sugar, and eight parts of water. With this solution the pigment giving the desired colour is next mixed, which may be Indian ink, either alone or mixed with lake and indigo, or any other suitable pigments. A glass plate having been coated with plain collodion is allowed to dry, and again coated with the above mixture.

You can then remove the tissue from the glass, and will find it very flexible, tough, and elastic, folding without creasing or breaking, and bearing general rough treatment without injury. On this the image is printed in the usual pressure-frame, with the collodion surface in contact with the negative, the image being printed not *upon*, but *through* the film. When removed from the pressure or printing-frame, after an exposure which it is difficult to regulate without experience, the tissue is again mounted, with a solution of India-rubber and damar in benzole, on paper or any similar surface (collodion, and also what is called "india-rubber varnish," thinned with benzole, answer the same purpose), and the process of development is merely that of immersing it in hot water, about 100° Fahr., when portions of the gelatine dissolve out in proportion to the degree in which they have been acted upon by the light, and in the course of two or three hours the image is perfect, when a camel-hair brush is passed over them ; they are subjected to the action of a stream of hot water, dried, mounted, and rolled in the usual way. The image being printed through from the back is of course reversed, but should this prove objectionable, either the original negative may be itself taken through instead of on the glass; or, as is more commonly done, the print may be mounted face downward, and the paper attached prior to the process of development readily removed by the aid of a little benzole.

Let us now glance at M. Fargier's process. A plate of glass is coated with a mixture of carbon gelatine, and the bichromate is exposed in the pressure frame, and coated with collodion previous to development. The water then plays its part in detaching the film and developing the image by dissolving out the soluble portions at one and the same time, and last, though not least, you have to dodge that curling and diving film until you can capture and mount it in the usual way.

Thus we see, how by a process very similar to that of Mr. Swan, results as perfect were attainable about four years ago ; but in addition to this fact, as affecting the safety and powers of Mr. Swan's patent, we must remember that Pouncy of Dorchester, Davies of Edinburgh, Beattie of Dublin, M. C. Lea of America, and many others, exhibited specimens by processes closely resembling Mr. Swan's, long before that gentleman's patents were secured, and that, moreover, Mr. Burnet first pointed out, in the *British Journal of Photography*—if we remember rightly—the advantage in carbon experiments of printing through the paper, although Mr. Swan says he is indebted for this to Mr. Blair. Again, the use of bichromates of potash and ammonia were originally suggested by Ponton. Fox Talbot first made a similar use of gelatine, and the idea of mixing a pigment therewith is the property of Poitevin ; while in America a patent was taken out some years ago for the application of sugar to effect a very similar purpose. All these things it seems to us may affect the working of Mr. Swan's patent, and should therefore receive his attention.

As most photographers are now engaged in testing Mr. Swan's process, a few hints relative thereto may prove acceptable to such of our readers as are adepts in what is called "the black art."

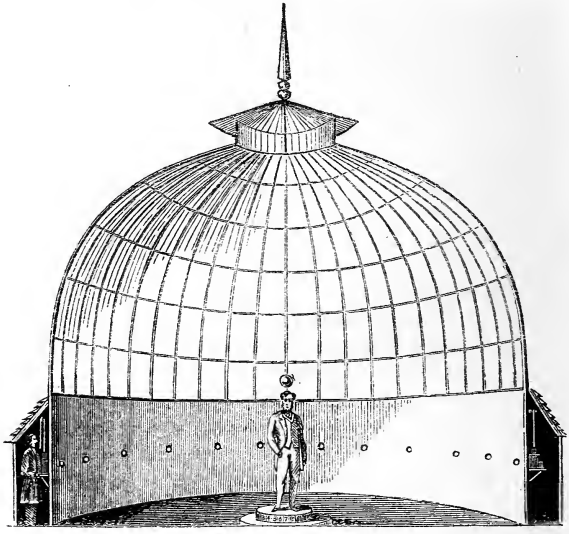
Different kinds of gelatine have been used, and, considering how variously this article is prepared, it will not surprise when we add, with various

degrees of success or failure; some specimens being too soluble and some insoluble. If an unnecessarily thick film of gelatine be used, the drying is retarded, and the tissue becomes less manageable in mounting; if too thin there is a loss of power and half-tone. A loss of its setting properties will result from boiling the gelatine too long in its first preparation. It is desirable to ascertain the *minimum* quantity of bichromate that can be added without running the risk of insensitiveness arising from the use of too little. When the tissue is dry it should be excluded from the air, which hastens its spontaneous insolubility, especially if a large quantity of the bichromate be used, through excess of which the gelatine may become insoluble even before it is exposed to light. Mr. Cooper, at the meeting of the South London Photographic Society, referred to above, recommended three instead of four parts of water to one of gelatine, or, where the latter is of the softest kind, even two parts of water; but said the quantity will have to be varied according to the hardness of the gelatine. He pointed out as one of the results attending the use of too thin a solution of gelatine, the fact of the pigment being apt to separate itself and run into eccentric forms upon the surface of the collodion, instead of giving a film of uniform colour. For mounting, previously to development, Mr. Cooper prepared two solutions—No. 1 containing six grains of pure india-rubber to the ounce of benzole, and No. 2 consisting of the same quantity of india-rubber with ten grains of damar, in one ounce of the same solvent. The paper was *immersed* in No. 1, and the tissue *floated* on No. 2, and when both were dry and placed in contact, pressure and gentle rubbing sufficed to produce perfect adherence. For the re-mounting, gelatine has been strongly recommended. The collodion used should give a very transparent, but at the same time, thick strong film. It is advisable before applying the gelatine to the surface of the collodion to gently warm the plate, the flow of the solution may be aided with a glass rod, and care should be taken to get an even surface of uniform thickness; the time required for the drying of this will be about twelve hours, but will of course vary with the temperature and the thickness of the film. The sensitiveness of the film is said to be increased within certain limits by keeping. It is dangerous to hurry the development by increasing the temperature of the water, although when one is anxiously waiting to see the results of early experiments there is great temptation to do so.

Photo-Sculpture.—We no longer wonder at seeing our portraits painted to perfection in a few seconds by the operations of mere sun-light, because the fact is a familiar one, and although the idea of sculpture executed by the same agency is rather startling at first, it is in sober reality a far more simple and less wonderful thing. A process which will give any number of outlines of any number of surfaces at one and the same time, must, when all these outlines are re-combined, give again the relief from which they had their origin. Acting on this idea, M. Willême invented the process of Photo-Sculpture, which has recently been carried out in Paris, and is now being introduced in London by Mr. Claudet.

The studio in which the four-and-twenty photographs necessary for the process of Photo-Sculpture are obtained in Paris, is a circular one, having a large dome of glass. From the exact centre of this dome, immediately

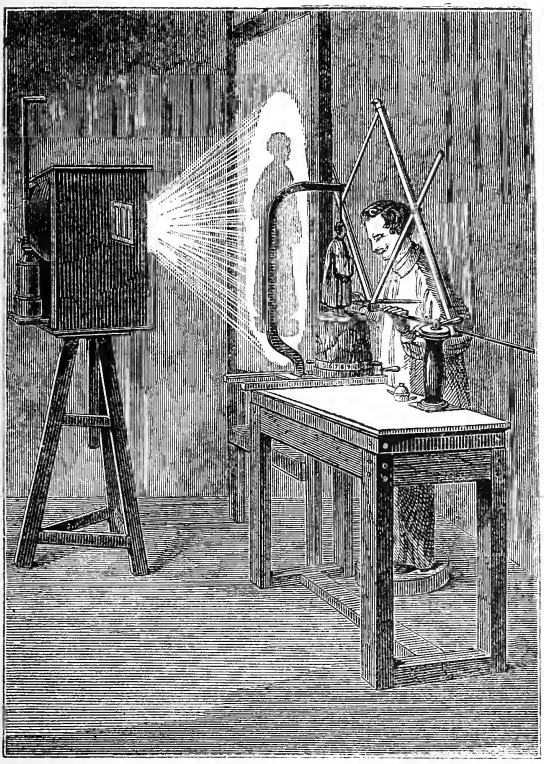
above the exact centre of a circular platform, hangs a plumb line, and around are four-and-twenty circular windows ranged at regular distances, which are four-and-twenty lenses pointing in a line, with four-and-twenty numerals painted at equal distances apart round the side of the smaller of the two circular platforms. When the subject to be operated on is placed on this platform so that the plumb-line indicates an imaginary line piercing the model's head, and passing through the centre of the platform, four-and-twenty photographs are instantly taken by invisible operators (see cut), and so far as regards the sitter the process is complete.



Not so, however, with regard to the result. In a dark room a magic lantern is placed opposite a large sheet of ground-glass. Beside this ground-glass stands a bench, and upon this bench a disc divided into four-and twenty spaces, each one numbered. Upon this disc is a roughly shaped-out mass of modelling clay, through which passes a rod of iron in the direction assumed by the imaginary line above noticed. The operators having taken their places, one attends to the lantern, and one so arranges a pantograph, that when its tracing-point touches the ground glass, a cutting-point at its other end touches the modelling clay. And now the work begins. The four-and-twenty photographs on glass previously taken have been fitted in numerical order around the edge of a disc, which turns like the wheel of a rudder, and is made to throw each of its four-and-twenty images slowly, and one after the other, on the sheet of ground-glass behind which stands the man with the pantograph. This operator carefully traces the outlines of each photograph with the fine tracing-point of his instrument, and as he does so, the cutting-point as slowly cuts away the modelling clay, until when he has traced the outlines of one photograph, there is its profile cut in the clay. The disc of the photographs makes one turn, the disc on which the modelling clay stands does

the same, another photograph is traced, another profile cut, and so on until the whole four-and-twenty photographs are profiled out, and a rough but even now strikingly truthful statuette in clay stands before us. (See cut.)

But in this stage of its progress it must obviously be very far from perfect. So far, the process only gives us the exact proportions of the relative parts, the broad and general masses as it were, leaving the finer details and more refined and subtle contours for the artist's finishing hand, without which it would be simply useless. It is not, as some of our con-



temporaries would lead their readers to suppose, immediately ready for being converted into a mould from which any number of copies may be taken; on the contrary, it must then pass into the sculptor's hands, and receive no small share of artistic labour before it can be so used. Four-and-twenty such outlines as can be traced with a fine point if placed in close contact, would cover a very small part of the surface which the statuette, bust, or whatever it may be, represents; and consequently there must be a very large quantity of surface really although not apparently unrepresented by the four-and-twenty photographs, and consequently by the four-and-twenty profiles cut in the soft clay. M. Claudet, we believe,

uses as few as six photographs for his specimens of photo-sculpture, and these works must therefore owe a great deal more to the sculptor than to the photographer.

The Chementi Pictures.—The controversy started by Sir David Brewster concerning these pictures, and which he advanced and argued from as having been executed in the middle of the seventeenth century for stereoscopic purposes, has been recently revived in the pages of the *British Journal of Photography* by Professor E. Emerson, in reply to a letter from Sir David published in the *Philosophical Magazine* for January last, which letter was itself a reply to remarks contained in an article in the aforesaid British Journal on "The Perception of Relief," written by Professor Emerson. Mr. Emerson states that copies made for him by hand from the photographs of these drawings convey an amount of relief neither greater nor less than that obtained from the photographs themselves, and gives, as illustrative of the ease with which even our much-talked of "own eyes" will deceive us, the fact that he has frequently mounted "two identical or right-eye views of the same scene side by side, and never failed to get a verdict, even from very skilful observers, that they exhibited stereoscopic effect, which was impossible." The Professor says, if Chementi had executed works which must have been such startling novelties, it is neither likely that his discovery would have become lost, nor that only one specimen of it would have been now in existence, although we think both these circumstances might be shown, by historical evidence, to be by no means improbable. The supposed stereoscope, bearing date 1670, advanced in evidence by Sir David Brewster, is asserted to be no stereoscope, and the size of the Chementi drawings, viz., "about twelve inches high, by eight and a half broad," is certainly evidence on the side of the Professor. After giving very imperfect woodcuts of the drawings, and advancing the publicly expressed opinions of various gentlemen in support of his views, Mr. Emerson winds up with a long series of measurements, which, taken in conjunction with the principles governing the perception of solidity, at least show that if these drawings were intentionally stereoscopic, their execution could not have been based on such scientific calculations. Our own opinion of this controversy is simply that it is a very useless one, because the evidence on either side is insufficient for the formation of any specially useful or important conclusions.

PHYSICS.

Spectroscope for Stellar Investigation.—Professor Miller and Mr. Huggins recently presented (May 26) a valuable paper to the Royal Society upon the spectra of some of the fixed stars, and employed in these researches an instrument of the following description :—In the construction of the spectroscope a plano-convex cylindrical lens, of fourteen inches focal length, was employed to convert the image of the star into a narrow line of light, which was made to fall upon a very fine slit, behind which was placed an achromatic *collimating* lens. The dispersing portion of the arrangement consisted of two dense flint-glass prisms, and the spectrum was viewed

through a small achromatic telescope, with a magnifying power of between five and six diameters. Angular measures of the different parts of the spectrum were obtained by means of a micrometric screw, by which the position of the small telescope was regulated. A reflecting prism was placed over one half of the slit of the spectroscope, and by means of a mirror suitably adjusted, the spectra of comparison were viewed simultaneously with the stellar spectra.—Vide *Chemical News*, June 11th.

Action of Heat on Minerals.—Dr. Phipson draws two conclusions from his experiments on this subject. (1) That mineral bodies can absorb a certain amount of heat (not indicated by the thermometer), which becomes latent, and this is effected without the bodies undergoing any change of state. (2) That they slowly part with this heat again, until they have acquired their original densities which had been diminished. (3) This property having been found to be possessed by very many substances, it will probably be observed, ere long, in all bodies without exception.—Vide a paper read before the Royal Society, May 26, 1864.

Hicks' Standard Barometer.—This instrument, which was described to one of our scientific societies as an entirely new instrument, is apparently an invention of ancient date. In a letter to the editor of the *Chemical News* (May 28), Mr. W. Symons alleges that the apparatus in question has been described, in principle, in the seventh edition of the "Encyclopædia Britannica," which appeared in 1842, and remarks that the circumstance does not reflect credit upon those connected with the institution to which he refers.

New Electro-magnetic Induction Machine.—Mr. J. B. Thompson has invented a machine of this kind, the proposed objects being (1) To obtain by means of magnetic induction, from a few voltaic pairs, a continuous stream of electricity in one direction, and of any required tension. (2) The induced stream of electricity to be as manageable as that from the small exciting battery. (3) The machine to be entirely self-acting. These ends have been attained: 1st, By associating two or more induction coils in such a manner that when the magnetism in one coil or set of coils ceases, it shall be excited in the other, the resulting induced alternate current or sets of currents being caused to flow in one and the same direction. 2nd, These induced currents are brought under control by means of a four-port reversing commutator, whose diagonal parts are connected so that by simple oscillation its contacts are reversed, just before the reversal of the currents. 3rd, The small exciting battery used in this machine not only excites the electro-magnets in the coils, but at the same time drives a rotatory break and oscillating commutator. By means of these several contrivances the machine becomes a perfectly self-acting one. The size of the battery being diminished, as also the consumption of material and the labour, it must effect a considerable pecuniary saving, and on this account commends itself to the notice of physicists.—Vide *Electrician*, May, 1864.

Improved Form of Telegraph Insulator.—At a recent meeting of the Franklin Institute, Mr. Thayer exhibited his new form of insulator. The body is composed of a block of glass protected by a well-shaped casing of cast-iron, through an opening in the top of which the glass projects, the casing being strongly cemented to the glass. To that portion of the glass

projecting from the top of the casing is cemented a metal cap, from which project three prongs, so arranged that the wire must be slightly bent in passing between them, it being thus prevented from slipping. The insulator is secured in its place by a pin which projects from the pole into an opening in the under side of the glass. Both the cup and casing are thus so completely insulated, that there can be no communication between the wire and the pole. This apparatus appears from its simplicity to be an economical and cheap one.

Different Spectra produced by the same Element.—From the experiments of MM. Plücker and Hittorf, it has been proved that certain bodies, such as nitrogen and sulphur, do not give a unique spectrum, but, according to the temperature to which the incandescent vapour is submitted, two very distinct spectra. To ascertain this, they passed through the tubes, containing gas or vapour at a pressure of a few centimètres, first the ordinary current of Ruhmkorff's induction coil, then the same current with its calorific action increased by the interposition of a Leyden jar. By varying the surface of the jar and thus gradually raising the temperature of the gaseous body, they found that the transition from one spectrum to another was rapidly accomplished. Hence it would seem that a considerable molecular alteration of the body had taken place. When the temperature was lowered the distinction disappeared. The first spectrum was composed of large bands, more or less regular, but oftener presenting the appearances of channelled spaces cut by black rays. The second exhibited brilliant rays on a more or less luminous ground. For a more detailed account of these researches we must refer our readers to the *Chemical News*, No. 229, p. 195.

Theory of the Candle Flame.—M. Morren, who has been one of the latest writers upon this subject, thus sums up his opinion. The theory of the candle flame now admitted must be somewhat modified. The base of the flame being blue, is the vapour of carbon preserved from combustion, but kept at a very high temperature by the envelope of hydrogen, the more combustible element of the gaseous carbides from the decomposition of wax; the hydrogen alone uniting with the oxygen of the air. Above the blue part comes the luminous part, produced by the passage of the carbon from the gaseous to the solid state, giving out in the passage a considerable amount of heat. The black cone which surrounds the wick of the candle is formed of gaseous carbides of hydrogen, which only burn in the upper part of the flame when they come into contact with oxygen. Hydrogen, besides being not only very combustible, but very subtle, diffusive, and penetrating, its combustion takes place under conditions in which it would be impossible for other gaseous bodies to burn. If a candle be gently moved so that the flame may be inclined, and the air allowed to come in contact with the vapour of hydrocarbons which surround the wick, we see the hydrogen take fire, and above the flame appears the blue vapour of carbon.—Vide *Chemical News*, No. 224.

Electric Properties of Gun-cotton.—The late experiments of Professor Johnston on the subject of the electro-developing power of gun-cotton, have been carried out by Professor Silliman, with similar results in both cases. The latter savan states that gun-cotton produces the same excite-

ment of positive electricity as pyroxiline paper does. The most energetic effects are produced when vulcanised india-rubber is the electric. The opposite effects produced in this substance by flannel and gun cotton, or pyroxiline paper, are very striking, and will form a good lecture-room illustration. These substances also produce powerful positive excitement in glass. It is difficult from the use of pith balls alone to determine which produces the most powerful positive excitement, glass or hard rubber, when excited by gun cotton or pyroxiline paper. This seeming anomaly, confounding our ordinary means of discrimination in cases of electrical excitement, demands further investigation. It would appear that, of negative electrics yet observed, these azotised species of cellulose are the most remarkable, in comparison with which the most highly negative electrics hitherto known become positive.

The new Atlantic Cable.—One of the improvements in this cable is the mode in which the gutta-percha coating is applied. Some time ago Mr. Chatterton discovered and patented a compound that is said to have the property of causing the coatings of gutta-percha to adhere firmly, without the injurious use of naphtha, so as to form a completely solid core. The wires having been formed into a strand, and six wires twisted round a central one, they are passed through a vessel containing Chatterton's compound, and are then covered with their first coat of gutta-percha to a depth of about an eighth of an inch. After having been examined by hydraulic pressure and by hand, the core receives another coating of Chatterton's compound, and then another layer of gutta-percha, and so on till it has attained a diameter of a little more than half an inch. It is then covered with the solid wires drawn from Webster's and Horsfall's homogeneous iron, each capable of sustaining a strain of 1,000 lb., at which strain it only stretches one per cent. These homogeneous iron wires are surrounded separately with five strands of Manilla yarn, saturated with a preservative compound, the poisonous qualities of which have been found by experiment to prevent its destruction by animals; and the whole are laid spirally round the core, which latter is padded with ordinary hemp, saturated with preservative mixture. The weight of the cable when completed is 25 cwt. per mile, when weighed in air, but its specific gravity is said to be so little, that it is capable of bearing eleven miles of its length when in water, a strain it is quite impossible it should ever be put to, the deepest water encountered, in laying the old cable, being less than $2\frac{1}{2}$ nautical miles. The company have made arrangements by which they can pay out fifty miles per week of the new cable.—Vide *The Artizan*, June, 1864.

Improved Diffraction-showing Apparatus.—At the conversazione held in University College last June Messrs. Horne & Thornthwaite exhibited a very beautiful instrument of the above kind. It consisted of a telescope mounted horizontally, and having at some distance from it, but exactly in its longitudinal axis, a small aperture, through which passed a beam of oxy-calcium light. Immediately in front of the object-glass was placed a disk of glass, on which were photographed some hundred figures of different forms, and all so minute as just to be seen by the naked eye. This plate, or disk, was so arranged that, by means of a cogged wheel,

which formed its periphery, and a screw, the figures could be brought into view successively, the movement being a spiral one, inasmuch as there was no fixed axis,—a spring in front keeping the disk *in situ*. Nothing could exceed the beauty of the various images produced in this instrument by the diffraction of the light as it traversed the minute figures. We learn that this enterprising firm is about to introduce a new polariscope also, by which even the angular difficulties presented by crystals of sulphate of copper will be overcome.

Machine for ascertaining Ocean Depths.—M. Goüezel has invented a new form of this apparatus. The great objection to the variety now employed is, that currents in the water cause the line of suspension to be bent, and so the apparent depth, judged of by the length of line employed, is much greater than the real depth. The purpose to which the new "sounder" is intended to be applied is for the construction of a chart of the bottom of the ocean, which would be of service in the laying of telegraph cables; and apart from such uses, the possession of such a map would be of great scientific interest. In M. Goüezel's apparatus the suspension line is altogether dispensed with; a rod of iron, furnished with nippers at its extremity, supports a cylindrical weight capable of being detached from the rod, and above the weight is fixed a float of hollow metal. On striking the bottom of the water the weight is detached and the remainder floats to the surface; a small clock, inclosed in the apparatus, is so arranged as to close at the moment of concussion, so that the time of descent can be estimated; a bell is also attached; an easily visible object is placed above the whole, so that there is no difficulty in finding the apparatus after its arrival at the surface.

Analysis of Solar Light.—There are few researches of more interest than those of M. Janssen, referring to the modifications presented by the solar spectrum according to the different hours of the day. This savan has discovered that the obscure bands which present themselves under certain circumstances may be resolved into numerous and very distinct rays. Moreover, these rays are perceptible, not only during the morning and evening, when the sun is near the horizon, but even—though less clearly—at midday, when the sun is at its highest point. Finally, these same rays have been observed in light from both the moon and stars, hence they cannot result from any peculiar influence of our atmosphere. This discovery was achieved with a small spectroscope with direct vision, somewhat like Amici's, but with modifications in adaptation to the objects held in view.—Vide *Comptes Rendus*, May 2, 1864.

Advantages of Fixed Conductors.—M. Volpicelli, who has given great consideration to the relative examination of various forms of electric conductors, has been at last impressed with the conviction that the fixed variety is the most useful and effective. The following are some of the reasons which he gives in support of his choice:—

1st. It cannot be logically denied that the fixed conductor, combined with the condenser, has the power of manifesting atmospheric electricity very well.

2nd. M. Peltier has demonstrated, by a series of experiments, that

the electrical effects of a moveable conductor are due rather to the negative electricity of the earth than to the electricity of the atmosphere.

3rd. It is not true, that in calms the electricity of the atmosphere is invariably positive, as the moveable conductor would lead us to think.—Vide *Comptes Rendus*, lviii., 14.

Production of Ozone by the Mechanical Action of Ventilating Machines.—In a paper which appeared not long ago in the *Comptes Rendus*, M. Saintpierre records some remarkable facts in connection with the production of ozone by the mechanical propulsion of air. In the exit-tube of the blowing-machine of a foundry furnace he placed several bands of iodide of starch paper, and he exposed as many to the ordinary influence of the atmosphere; and he found that whilst the latter underwent no change, even after five hours' exposure, the former presented the characteristic violet tint in the course of about ten minutes. The staining corresponded only to about 3° of the ozonometric scale. This was attributed to the fact that, as fast as the tint was developed, it was destroyed by the currents of air, an action which was afterwards found to produce such an effect by M. Saintpierre. May it not be possible to account for the results arrived at by supposing that the friction of the air against the surface of the tube developed electricity, and that this, in its turn, produced the ozone? We fancy the action must be an indirect one, and do not see so much of the marvellous in it as M. Saintpierre would have us observe.—Vide *Comptes Rendus*, lviii., No. 9.

ZOOLOGY AND COMPARATIVE ANATOMY.

Tubularia not Parthenogenous.—Professor H. J. Clark, of Harvard University, U. S., announces the discovery of the eggs of Tubularia. He has traced the development of the ovum in three distinct species, from its inception to the time of its escape, as a hydroid form, from the medusoid genital. He is not surprised that the egg has hitherto eluded the observation of naturalists; for its outlines are so faint that it might be put down as one of the tests of a first-class objective. Although he had obtained a glimpse of it with a Tolles' $\frac{1}{2}$-inch power, it was not till he employed a $\frac{1}{4}$-inch objective of the same maker, that he gained a clear and immutable view of it. He believes that in order thoroughly to understand the various steps in the development, it is necessary to admit the existence of a muscular layer in all these hydrozoa. This layer consists of a thin longitudinally fibrillated tissue which intervenes between the outer and inner walls of the stem, disc, tentacles, and branching stems of the genitalia; and whenever the latter pullulate to form a genital sac—a medusoid—all the cellular and muscular elements enter into the operation, and thus there arises at first a highly contracted triple-walled hernia, the outer wall of which consists of a single stratum of broad cells, each containing a large nucleus; the middle wall or stratum forms the muscular layer; and the innermost wall is made up of a single layer of very large prismatic cells. This is the first stage of medusoid development. Hardly, however, has the bud declared itself, before the ovigerous layer

begins to develop. This is done in a very simple manner. At the end of the bud the inner wall, and with it the muscular layer, recede from the outer wall, and leave between them a space which is occupied by a distinct, peculiarly coloured substance, which is no less than the incipient ovigerous layer. Contemporary with the origin of this layer, the eggs appear: in fact they may be said to form nine-tenths of the bulk of this stratum, the remainder constituting the intercellular blastema. The eggs, although eventually very numerous, are at first few in number, perhaps five or six, and compare in size with the cells of the outer wall of the bud. The germinal vesicle, which is very distinct, occupies about one-third of the entire diameter of the ovum. As the space between the walls of the bud increases, it gradually assumes a spheroidal form; and as it is constantly filled by the ovigerous layer, the latter also becomes globular. Surrounding this space we have, on one side the outer wall at the end of the bud, and on the other side the inner wall lined by the muscular layer, and forming a sort of cup-shaped cavity. Gradually, and during the process of growth, the edge of the cup becomes narrowed, and by degrees closes over the intervening space occupied by the ovigerous layer, and shuts the latter off from the outer wall. Thus we have a medusoid whose structure from without is,—an outer wall and outer muscular layer, an inner cellular layer and inner muscular layer, and an ovigerous stratum in the centre. In this central matrix the eggs undergo their development, move freely within the genital, and eventually make their escape into the open sea.—Vide Silliman's *American Journal*, vol. xxxvii., No. 109.

Pedantic Terminology.—A memoir appeared some time ago upon a system of classification of insects based upon characters of the head; but it is so full of barbarous and unpronounceable expressions, as to be quite beyond the comprehension of most naturalists. Every fourth word in the paper we refer to is one of the author's own invention, and as no explanation of its meaning is appended, the drift of the text is quite unintelligible. Whether the employment of new terms results from self-conceit or a desire to advance science, we cannot with certainty aver; but it appears to us to have far more of its origin in the former than in the latter. How can a writer expect his opinions to be accepted when his descriptions are trammelled by such expressions as the following: "*Megasthenes*," "*microsthenes*," "*amplificate*," "*perfunctionate*," "*pteroprosthenics*," &c.

Exeter Hall Science.—Most of our readers are aware of the difficulties raised by the Christian Young Men's Association relative to the publication of Professor Owen's lecture. We believe that the lecture as published by that body was not exactly the one which Professor Owen delivered; it is therefore satisfactory to find that the original lecture has been published by Messrs. Longman under the superintendence of the Professor himself. To this pamphlet are appended several notes, in which the objections urged by certain divines are ably met. The Christian spirit in which Professor Owen advances his opinions must appeal to all who are desirous of examining the question of Scriptural science in an impartial manner. His analogies are admirably drawn, and must convince even the most unintelligent readers.

British Polyzoa.—Notwithstanding the valuable researches of Busk, Saärs, and others, a good deal remained to be done in the way of describing our native polyzoa. That veteran naturalist, Mr. Joshua Alder, has now, however, taken the matter up, and, as the fruits of his present inquiries, gives us descriptions of a new genus (*Palmicellaria*) and two new species (*P. elegans* and *Eschara lorea*). He gives the following description of the new genus: polyzoary erect, calcareous, inarticulate, cylindrical, smooth, branching dichotomously; cells disposed in four longitudinal alternate series, those in the two opposite series being on the same level; apertures circular, opening vertically within a slight concavity, with a broad, projecting palmate expansion in front, bearing an avicularium. This genus, in which as yet no ovi-cells have been observed, evidently occupies a position between Cellepora and Quadricellaria.—Vide *Quarterly Journal of Microscopical Science*, April, 1864.

Are Zoosperms secreted in the Ovary of the Snail?—This question is answered in the affirmative by Mr. Sanders. The only evidence, however, which he adduces is, that he observed the zoosperms within the egg-forming sac. It is well known to comparative anatomists that they are frequently found in that locality; but that is *no argument* in support of the assertion that the mollusk in question is hermaphrodite. As well might Mr. Sanders assume that because zoosperms are found in the ovaria of vertebrates, these animals are also androgynous. Their presence merely indicates that the ova are about to undergo fertilization. The zoosperms in the ovary are invariably found in the isolated state; but when taken from the sperm-sac they are found in clusters. This fact is quite sufficient to demonstrate to all reflecting persons, that the sperm, wherever it be first secreted, is not formed in the ovary.—Vide *Quarterly Journal of Microscopical Science*, April, 1864, and October, 1861.

Zoology and Music.—Our contemporary, the *Microscopical Journal*, is not exclusively devoted to *mere scientific* objects. For example, we learn from a report of the proceedings of the Hull Microscopical Society that "to add to the pleasures of the evening a miscellaneous selection of music was performed at intervals, several accomplished local amateurs being assisted by Fraülein Eyserbeck and Fraülein Reichmann. The first mentioned of these ladies sang exquisitely, and the latter also displayed great skill as a pianist, and the applause which followed their perforamnce was appreciated by, we should say, as critical an audience as it would be possible to bring together in Hull!"

The Upper Jaw of the Greenlander.—Dr. C. Carus contributed a paper to the last number of the *Anthropological Review*, in which he describes some peculiar features observable in the upper jaw of a Greenlander's skull. In the first part of his *Atlas on Cranioscopy*, which was published in 1843, he mentioned that in the skull of a Greenlander figured therein, he had found a decided separation between the upper jawbone and the intermaxillary. This separation resembled that seen in the fœtal skull, and in quadrupeds, and hence indicated an approach to the lower animals. Since that, he was fortunate enough to obtain another Greenland skull, and in it he perceived exactly the same conformation of parts seen in the first. If this character should prove common to all Greenlander skulls, it would

argue a lower position for this race than it is thought to hold now, and the extreme voracity of the Esquimaux races in the north of North America could then be associated with this peculiarity.

Natural Selection.—In a paper read before the Anthropological Society by Mr. A. R. Wallace, the following statements occur, which as they help to account for the variation and transmutation of species, we here transcribe:—(1) Peculiarities of every kind are more or less hereditary. (2) The offspring of every animal vary more or less in all parts of their organization. (3) The universe in which these animals live is not absolutely invariable. (4) The animals in any country (those at least which are not dying out) must at each successive period be brought into harmony with the surrounding conditions. These are all the elements required for change of form and structure in animals, keeping exact pace with changes of whatever nature in the surrounding universe. Such changes must be slow, for the changes in the universe must be very slow; but just as these slow changes become important, when we look at results, after long periods of action, as we do when we perceive the alterations of the earth's surface during geological epochs; so the parallel changes in animal form become more and more striking, according as the time they have been going on is great, as we see when we compare our living animals with those which we disentomb from each successively older geological formation.—Vide the *Anthropological Review*, May.

Poison Organs in a Fish.—Dr. Günther has discovered in a new species of fish (*Thalassophryne reticulata*) a peculiar organ for the infliction of poisonous wounds. It consists of four hollow spines, two of them being dorsal, and the others formed by the acute termination of the operculum posteriorly. The canal in the interior of the spine terminates in each case in a sac, in which the poisonous fluid is collected—the sac in question being connected by a small tube with the mucus-forming system of the cutis. In the specimen examined by Dr. Gunther, which had been in spirits nine months, the slightest pressure on the sac, seated on the operculum, caused a whitish fluid contained in it to flow freely from the hollow extremity of the opercular spine. The discoverer is of opinion that this organisation cannot be construed otherwise than as a poisonous organ, though it still remains to be proved—by actual experiment upon the living fish—that this is really the case.—Vide *Natural History Review*, April.

The Egg of Æpyornis Maximus has had a pamphlet devoted to it by Mr. G. D. Rowley, who is the possessor of the only specimen ever brought to this country. The colossal bird which deposited this ovum was formerly a native of the island of Madagascar. In shape it is an ellipse; its greater axis is about $12\frac{1}{4}$ inches, and its lesser one $9\frac{3}{8}$ inches; its great circumference is estimated at $34\frac{3}{16}$ inches, and its lesser at $29\frac{1}{8}$ inches, while it weighs no less than 3 lb. 11 oz. avoirdupois. Of course, such weight is no indication whatever of the weight of the egg in its natural state. M. Geoffrey St. Hilaire, who has examined both eggs and bones of this bird, supposes the creature, when living, to have been about 12 feet high. The contents of the eggs would be about 7 quarts 1 pint, or a volume equal to the contents of about 148 hen-eggs.

Salt Water Entomostraca found in Fresh Water.—The younger Saärs has been dredging in the Norwegian lakes, and has made some very interesting discoveries. In the deepest portion of the lake he drew up some of the mud, and found it to his astonishment full of a small red copepode, in which he at once recognized the salt-water species, *Harpacticus chelifer*, described by Lilljeborg. The presence of this crustacean was so unexpected, that in spite of the fresh-water forms which he had also found, he was obliged to satisfy himself by tasting, that the water was not brackish. This affords, though on a different scale, an interesting analogy to what has been recently observed in some of the great inland lakes of Sweden; viz., that the true inhabitants of the sea can in certain circumstances gradually accustom themselves to live in thoroughly fresh water. Here, however, the agency of change has not been great, alterations of physical conditions operating throughout thousands of years. The time in this instance has been much shorter. Apparently some very high flood or furious storm from the west has driven the sea up on some occasion into the loch, which lies close to the coast. Other salt-water species may probably have been carried into the loch at the same time, and perished by degrees as the water lost its saltness, while this little copepode was able to survive after every trace of salt had disappeared. —Vide *Annals of Natural History*, vol. xiii., No. 77.

New Forms of Mollusks.—The well-known conchologist, Mr. Lovell Reeve, deprecates the practice, at present too common, of giving mere varieties of shells new names, and describing them as specific forms. He illustrates his objections by alluding to the way in which Dr. P. P. Carpenter has given a name to a mere variety, while he at the same time expressed his belief that it was probably only a variety of one already named. Mr. Reeve predicts, that should ever the soft parts of the shells described by Dr. P. P. Carpenter be examined, it will be found that they are by no means "new forms."—*Ibid.*

Classification of the Hydroïda.—A great deal of confusion of zoïds with animals has resulted from the habit, heretofore much in vogue among zoologists, of giving distinct specific and generic titles to medusæ. It would be almost as justifiable to give separate names to the flower of a plant and the stem which supports it. Professor Allman has come to the rescue, and were it not for the adoption of a very cumbrous nomenclature, we think his efforts would be attended with success. The basis of his views may be thus expressed: every hydroïd whose life-history has come fully before us, consists (with only a single positively proved exception) of two sets of zoïds. One of them is destined for the nutrition of the colony, and has nothing to do with true generation; while the other is, on the contrary, destined for true generation, and has nothing to do with the nutrition of the colony. For the whole assemblage of the former the term *trophosome* has been proposed; and for that of the latter, the expression *gonosome*. Whether the gonosome remains attached to the trophosome permanently, or becomes in whole or in part free, thereby attaining an independent existence, it is equally necessary that it should take its place in our diagnosis of genera and species. An adequate conception of the hydroïd can thus only be obtained, by regarding it as the product of

two factors, one of them finding its expression in the trophosome, and the other in the gonosome.

Sphærularia Bombi.—This curious entozoon, which is found in the abdomen of the common humble bee, has been submitted to a minute examination by Mr. John Lubbock. These worms are so like the normal tissues of the insect's body that it is exceedingly difficult to distinguish them; and from the fact that they will live for a considerable period of time in water, it seems probable that they effect entrance into the body of the bee when the latter is "ferreting about, as it were, among moss and long grass." The sexes have been clearly pointed out, though as yet the male is known rather by negative than by absolute characters. The ova are never actually laid until the middle of April, and the young are not hatched out till a month later. The ovary consists of a mass of elongated lozenge-shaped cells, each with a distinct nucleus and nucleolus. No eggs appear to be produced in the lower portion of the ovary, which may be called the uterus, but they seem to arise in the upper part of the long single tube which constitutes the female generative organ, and to be pushed gradually forward by the pressure from behind.—Vide *Natural History Review*, April.

The Brain of the Chimpanzee.—When some time ago Professor Huxley asserted that man is not the only animal which possesses a cerebrum that overlaps the cerebellum, grave comparative anatomists assured him that he must have been mistaken. Since that date, his statement has been verified by hosts of observers, and now Dr. Embleton, of the University of Durham, gives the following evidence, as deduced from an examination of a young ape's brain:—The vault of the cranium having been removed, a correct cast of the whole cerebral surface was secured. Before the brain was in any way disturbed from its natural position, the relation of the posterior lobes of the cerebrum to the cerebellum was carefully observed, and the persons present, anatomists and naturalists, were unanimous in declaring that *the former projected backwards over the latter a quarter of an inch.* In the removal of the brain the disposition of the membranes and nerves was observed to be strikingly similar to the corresponding human part. The arterial circle of Willis was quite human.

Alternation of Generations in the Annelida.—Professor Agassiz has found lately in the Boston harbour a species of annelid, *Autolytus cornutus*, which exhibits this phenomenon: the males are very unlike the females, and there also exists a third form—the asexual, which produces the other by gemmation at its posterior extremity. The females at the moment of their detachment from the agamic individuals possess no ovigerous sac; but this is soon formed and the ova are produced in its interior. The embryos are rapidly developed, and their escape from the sac appears to cause the death of the female; at least, Professor Agassiz has never met with females after their embryos have escaped. The embryos at the moment of issuing from the sac have a triangular outline, their body diminishing rapidly towards the posterior extremity.—Vide *Journal of the Boston Society of Natural History*, viii., p. 392.

INDEX.

Acid, Vanadic 110
Aconcagua, Volcano of 113
Æpyorius Maximus, Egg of 564
Agriculture, Summary of.... 381, 514
Ailanthus, the 286
Air Breathers in Nova Scotia.... 257
Air in Swim-bladder of Fish 138
Albertite in Scotland, Discovery.. 127
Alcohol and Olefiant Gas..... 254
,, in Diseases, Action of .. 268
Aldehyde, Method of Producing.. 523
Alligator, Entozoa in Stomach of . 424
Alps, Railway Tunnel through the, Plate VII..... 157
Aluminium, Coating Iron with .. 404
Alunite, Characters of the 127
Amœbæ, Reproductive Phenomena 284
Amalgamator, New Form of 545
Amblygonite 126
American Lakes, Origin of 531
Angler-Naturalist, the 89
Angina pectoris, Cause of 266
Aniline Dyes. By Dr. Phipson, Plate XVI. 429
Animals, Production of Sexes in.. 427
Annelida, Alternation of Generations in 566
Ansted, Professor, Physical Geography of the Ionian Islands .. 44
Anthropology, Meaning of 423
Anti-Darwinianism 501
Antimony, Preparation of 123
Apjohn, M.D., J., Manual of the Metalloids 231
Aqueous Rock Groups, Synoptical Table of 95
Arkansite, Reproduction of..... 126
Armour Plates 116, 238, 538
Arnott, Dr., Natural Philosophy 376
Ascophora nigrans, Artificial Development of 104
Asphalte Oil, Substitute for Coal 271
Asthma, New Remedy for 402
Astronomy, Summary of, 97, 243, 382, 515
Atlantic Cable, New..... 559
Atmosphere, Carbonic Acid in .. 109
,, Organic Corpuscles in 104
,, Rotation of Upper Currents..... 547
Aymestry Limestone, Relation of to Lower Ludlow..... 115
Azulene, Optical Properties of .. 421

Bacteria, in Typhoid Fever 270
,, Presence of in Blood.. 120
Ball, J., Guide to the Alps..... 224
Banana, Chemical Composition of Brazil 249
Barometers for Measuring Altitudes 70
Barometer, Hicks' Standard 557
Beetles new to Science 288
Belts, Voltaic 234
Bird's Australian Climates 509
Bisulphate of Carbon, Substitute 283
Blasting, Electric Fuse for 404
Blast-Furnace, Iron and Steel in 403
Blood, Action of Electricity on .. 129
,, Condition of, in Inflammation..... 542
,, Corpuscle, Nature of 399
,, Expulsion of Carbonic Acid from 542
,, Fatty Degeneration of.... 541
Bodily Work and Waste, by F. T. Bond, M.D. 149
Body, Organic Principles of 267
Boilers, Explosions of Steam.. 117, 272
Bond, F. J., Bodily Work and Waste..... 149
Bone Cave newly discovered 394
,, Growth of 119
Bones and Flint Implements at Audley-end 395
Boring Machine 124
Botanical Exercises, by Rev. G. Henslow..... 358
Botany and Vegetable Physiology 101
,, Summary of 247, 386, 518
,, to Palæontology, Relation of 101
Bothriocephalus latus, Development of 291
Bottles, Securing Corks in, Patent 80
Brachiopods in Isle of Wight 258
Brain of Insects, Functions of.... 140
Brand and Mildew, Plate VIII. 178
Brazil, Coal Measures in..... 398
Bree, M.D., C. R., Birds of Europe 228
Brookite, Reproduction of 126
Buds, the Evolution of..... 104
Byblus Rush, Distribution of 520

Caddis Worm, Habits of 285
Cadmium Alloys 124
Calabar Bean, Uses of 269

Camera, New..... 416
,, Patent Microscopic 133
Camphor on Surface of Water, Motions of..... 136
Candle Flame, Theory of..... 558
Cane, Sugar, Action of Fungi on 392
Canton, E., Diseases of the Eye.. 230
Carbon in Cast Iron, State of.... 123
Carbonic Acid in Tissues..... 401
Carbon Process, New 551
Carphosiderite, Characters of 408
Cartilage, Structure of..... 265
Cast Iron, Chemical Composition 274
,, Improved 546
Cave of Brunicquel, Human Jaws 395
Charcoal, Absorption of Gases by 282
Chementi Pictures, the..... 556
Chemical Preservation of Statues 525
,, Professorships 526
Chemistry, Summary of 106, 252, 389, 523
Chimpanzee, Brain of 566
Chinese Diatomaceæ..... 522
Chinese Record of Eclipses..... 517
Chrome, Pig Iron..... 545
Cinders, Utilization of..... 272
Classification of the Sciences 513
Clothing, by Dr. Lankester..... 338
Cluster-cups 20
Coal, Petroleum a Substitute of.. 545
,, Pits, Mineral Salts of..... 273
,, Marine Fossils of 396
,, Mine, New 546
,, Mines, Reports of Inspectors of..... 125
,, Waste of 271
Coccus, New Species of 137
Colburn's Inquiry into the Nature of Heat 513
Collieries, Ventilation of..... 272
Colouring Matter in Decayed Wood 105
Colza Plant, Disease of 549
Comets.....98, 244, 383, 385, 517
Conductors, Fixed..... 560
Cooke, M. C., Microscopic Fungi 20, 178, 317, 469
Copper, Blowpipe Reaction of.... 393
,, Manufacture of.....123, 405
Coral, A new..... 139
Corn in Pompeii, Chemical Compositions of..... 256
Cotton, Growth of Peruvian 387
Cranium, Development of 422
Crookes, W., Photographic Printing 1
Cryptogams in Eggs..... 522
Crystals in Intestines of Artemia Salina..... 139
Culley, R. S., Printing Telegraphs, Plate XI. 293
,, Handbook of Practical Telegraphy 377
Cytineæ, Anatomy of the 249

DANA'S Manual of Mineralogy .. 231
Davy Lamp, Improved Form of.. 404
Dead Sea, Composition of Water 261
Debus, Dr., Absorption and Radiation of Heat, Plate XIV. 351, 498
Diatoms..... 103, 522
Dickie's Flora of Ulster 506
Difflugia, Structure of..... 426
Diffraction showing Apparatus .. 559
Diluvial Deposit, Sandstone Hammer in..... 394
Dough, Machinery for Preparing.. 82
Dwellings, Pre-Historic, by G. E. Roberts, Plate XV..... 362

EAGLE, Imperial and Crested.... 291
Earth, Distance of Sun from the.. 97
Earthquake.....244, 261
,, Notes on by Rev. W. S. Symonds 204
Echinoderms, Embryology of 137
Eclipses, Chinese Records of, 386, 517
,, of the Sun and Moon .. 99
Eel and Conger, Orifices in Head of 426
Eggs, Spontaneous Alteration of.. 140
"Electric Fly," Real Nature of .. 419
Electric Spark, The 134
Electricity, Sound produced by .. 281
Electro - Magnetic Induction Machine..... 557
Elephas Meridionalis, Co-existence of Man with 116
Engine, The Steam, Speed of.... 262
Engraving, Photographic..... 412
Entomologist's Annual for 1864.. 512
Entomostracæ, Two Species of new 286
Entozoa in Stomach of Alligator.. 424
Epilepsy accompanied by Diabetes 540
Ethers..... 110, 391
Eta Argus 245
Evening Thoughts by a Physician 512
Exogenous Wood in Arenaceous Limestone 529
Eyelid, Bon Tumour in 541
Eye-Piece, Dawes' Solar 100

FERMENTATION in Liquids, Preventing 237
Fertilization of Corn, Artificial .. 102
Fibrine, Development of.... 267, 540
Firearms, Breech-loading 77
Fishes of Old Red Sandstone, by E. Ray Lankester, Plate XVII. 441
Fishes, Facial Bones of 290
Fish, Gases in Swim Bladder of 138, 288
Fish-hatching 85
Fish, Poison Organs in..... 564
Fixing Colours in Printing Calico 74
Fleas, On Sea Shore..... 286
Flesh as Food, Preparation of.... 269

Fletcher's Scientific Farming 509
Flint Weapons, Scriptural Mention of 398
Flourens's Examen du Livre de M. Darwin 501
Force and Matter, by Dr. Buchner 502
Fossil Birds of Central France .. 114
Fossil Bivalve Shells, Identification of 397
Fossil Bones, Striæ on 114
,, from Caverns of Toul 113
Fossil Insects of Carboniferous Formation in Illinois 529
Fossilization of West India Corals 532
Fossil Reindeer of Ireland 532
Fox, Dr., Parasitic Fungi 378
Fresh Air, by Dr. Lankester 6
Frogs, Habits of Australian Tree- 425
Fucus, the Kilkee 389
Funguses of England, the Esculent 90
Fungus, Salt, Remedy for Vine .. 250
Furnace, Gore's New 419
Furnaces, New Form of Siemen's 272
Furnace, Oil-lamp, for Melting Metals 405

Galileo's Weather-glass 420
Galloway, R., Second Step in Chemistry 375
Gamgee, J., Diseased Pork 141
Gamma Andromedæ 244
Gases 76, 132, 233, 247
Generation, Spontaneous 389
Geology and Palæontology, Summary of 110, 257, 394, 529
,, of New Zealand 113
,, of the Pyrenees 114
Geranium Maculatum an Astringent 121
Ghost Apparatus, Plate X 236
Glass, Ornamenting of, by Photography 131
Globe, Aërial Currents of 407
Glucinum and its Compounds 275
Glyptodon, Vertebro-sternal 114
Gold, Adulteration of Chloride of 415
,, Inlaying in Glass 241
Gore, G., New Furnace 419
Granite, Chabasite in 408
Granite, How formed 397
Granites of Ireland, Researches upon 394
Granite, Slickensides in 260
Greek Fire, by Dr. Richardson .. 164
Greenlander, Upper Jaw of 563
Griffith's Text-book of Microscope 504
Grotto of Laroque, Flint Weapons in 396
Gummic Acid from Glucose 524
Gunpowder 253, 391
Gun-Cotton 108, 528, 558

Hailstones, Peculiar Form of .. 548
Harrogate Water, Composition of 526
Heart 541, 543, 544
Heat, Absorption and Radiation of, by Prof. Debus, Plate XIV. 351, 498
Henslow, Rev. G., Botanical Exercises 358
Herrings and Herring-Fishing, by the Editor 304
High-pressure Boilers 536
Hind, J. R., Introduction to Astronomy 226
Honey-Bees, Acclimatization of .. 139
Home Walks and Holiday Rambles 96
Human Skin, Absorptive Power of 117
Hydrocyanic Acid, Properties of.. 528
Hydrogen, Siliciuretted 252
Hydroïda, Classification of 565
Hyæna, New Species of 398
Hymenophyllum and Trichomanes, Leaf Cells of 103, 248

Ice, Peculiar Properties of 418
Indium, Spectral Characters of .. 419
Infusoria, Distribution of 138
Insects and Crustacea, Homologies of 426
Insulator, Improved Form of 557
Iodide of Ammonium 527
Iodide of Mercury, Decomposition of 390
Ionian Islands, Physical Geography of the 44
Irish Crannoges 533
Iron 122, 125, 404, 405, 421, 547
Iron and Manna, Proto-iodide of 267
Ironstone, Nickel and Cobalt in.. 276
Iron Plates of Ships, Preservation of 124
Isothermals of British Isle 406

Jade, Nature of 126
Jeffrey's British Conchology 503
Johnston's Elements of Agricultural Chemistry, and Geology 508
Journal, New Mining 545
Jerdon's Birds of India 510
Jupiter 100
Jukes, J. B., Geology for Schools 222

Kappa Cancri, Occultation of 98, 244
Kidney, Structure of 119, 266
Kilkee Cliffs, Vegetation of 521
Kirke's Physiological Science 220

Lankester, Dr., Fresh Air 6
,, on Proper Clothing 338
,, E. Ray, Fishes of Old Red Sandstone, Plate XVII... 441

Lanterns, Submarine 240
Larch, New Acid in Bark of 250
Lawson, Dr., Herrings and Herring Fishing.... 304
,, Oysters and Oyster Culture, Plate XVIII. 448
Leaves, Expiration of 103
Leaves, Colour of, Relation between and Carbonic Acid 248
Leeches, Swallowing 266
Lemming, Emigration of..... 286
Lens, New Portrait..... 416
Lens, Triplet..... 279
Lepidolite, Presence of Thallium 550
Lepidosiren annectens, Anatomy of Brain of..... 290
Liebig, Baron, on Manures..... 438
Life, Struggle for among Plants.. 387
Lighting Theatres..... 75
Light, action of, on Plants 519
Limestone, to Harden and Colour 233
Ling, the Common 386
Liquids, Spheroidal Conditions of 417
Local Floras 223
Lunar Discoveries..... 243, 384
Lunar Nomenclature 246
Lyell, Sir C., Antiquity of Man 370
Lynn, W. T., First Principles of Natural Philosophy 376

Macdonald's Natural Phenomena 511
Mackie, S. J., Metropolitan Main Drainage Works.. 56
,, Pneumatic Despatch, Plate XIX. 460
McNicoll, D. H., M.D., Dictionary of Natural History Terms 225
Magnesium, Manufacture of 22
Manures, the Action of, by Baron Liebig 438
,, New Method of 514
Maps, Star..... 384
Marriages of Consanguinity 118
Mars 98
Mauveine 254
Mechanical Science 115, 262, 535
Medical Science .. 117, 265, 399, 538
Mercury, Liquids Adhesive to .. 133
Metallurgy and Mining, 122, 271, 403, 545
Metals, Imports of 546
Meteorology..... 246, 406, 547
Metropolitan Main Drainage Works by S. J. Mackie, F.G.S..... 56
Micro-photographs of Spinal-cord 541
Microscopes, New.....409, 410, 411
Microscopic Camera, Patent 133
,, Fungi, by M. C. Cooke 20, 178, 317, 469
,, Objects, on Mounting and Preparing, by Davies 505
Microscopy.....128, 274, 409, 548
Mitchell, J. M., Natural History of the Herring 374
Mildew and Brand, Plate VIII. 178, 476
Miller's Chemical Physics 229
Milne-Edwards, M., Manual of Zoology 221
Milton's Stream of Life 505
Mineralogy.....125, 275, 408, 549
Minerals, Action of Heat on 557
,, Action of Re-agents on 256
,, Electrical Relations of.. 127
,, Intimate Structure of .. 125
Mineral, New Steatitic..... 550
,, New Zeolitic..... 549
Molecular Motion, Conditions of 281
Mollusks 92, 288, 290, 565
Moon 384, 386
Moulds, Plate IX. 193
Moulin-Quignon, Human Jaw at 110
Muscles, Mechanical Power of .. 402
Muscular Tissue, Vegetable..... 103

Nascent-Hydrogen on Arsenic, Action of 254
Natural History and Sport in Moray..... 93
Naturalist on the River Amazon 83
Natural Laws of Husbandry, by Justus Von Liebig .. 217
,, Selection 564
Naval Architects' Institute..... 537
Nebulæ, Catalogue of 385
,, New..... 246, 516, 517
Nerve Cells of Frog, Structure of, Plate XXI. 538
Nerves, Influence of, upon Sphincters of Bladder 118
New Inventions..... 69, 233
Nitric Acid, Another Test for.... 252
Nitrites, Origin of..... 108
Nitrous Oxide in Dental Operations 403
Notation, the New 253
Nutmeg, Oil of..... 393

Ocean Depths, Machine for ascertaining 560
Oliver's Elementary Botany 507
Olives, Formation of Oil in..... 250
Omnibuses, Patent 80
Ophthalmoscopic Surgery..... 88
Orion, Nebula of 245, 384
,, Small Stars in Nebula of .. 245
Oxalic Acid, Purification of..... 392
Oxide of Copper, a New 252
Oxygen Baths, Use of 121
,, a Tetra-atomic Element.. 392
Oyster and Oyster Culture, by the Editor, Plate XVIII. 448
Ozone 255, 419, 561

Pachyderms of Paris Basin..... 395

Pagurus and Adamsia, Habits of.. 287
Palæontology, Relation of Botany 101
Palliser Bolts 538
Palmidactylism in several Generations..... 270
Palmogloea macrococca, What is 387
Pharmacopœia, New..... 401
Phillips's Atmospheric Electricity 513
Phipson, Dr., Aniline Dyes..... 429
Photogenic Pictures 72
Photographic Pictures, Minute and Magnified 71
,, Printing and Engraving 1
,, Society, the London 414
Photograph of the Sun..... 516
Photographs, Action of Hot Water on 416
,, Method of Restoring 416
,, reputed Watt..... 276, 413, 551
Photography 128, 276, 412, 551
,, British Journal of .. 280
,, in application to Microscope 279
Photometer, New 136
Photo-Sculpture..... 553
Phthisis, Use of Alcohol in 400
Physics 132, 280, 417, 556
Physical Geography and Geology 94
Pianofortes, Apparatus for Tuning 79
Pig-Iron, Titanium in 275
,, Vanadium in 408
Planet, New 515
Planets, Observations of Minor .. 244
Plants, Respiration of..... 389
,, Vascular System in..... 250
Plesiosaurus Cramptoni, Anatomy 259
Pneumatic Despatch, by S. J. Mackie, Plate XIX..... 460
Polariscope, New Lantern 417
Pollen Grains, Persistance of Fertilising Power in 519
Polyzoa, British 563
Pork, Diseased, by J. Gamgee .. 141
Postage Stamps, Damping 80
Potato, Effects of Phosphate and Potash on 381
Preserving Provisions 75
Pressure, Forging by 263
Prior, R. C. A., Popular Names of British Plants 228
Prize Essays, Medical 543
Projectiles, Destructive Effects of 116
Psorospermiæ, Real Nature of .. 138
Pteromalus, Metamorphoses of .. 136
Pumps, Centrifugal 264
Pupil, Dilatation of 402
Pyrenees Stone, Age in 261
Pyrites Burners, Thallium from .. 272
Pyro and Meta Arseniates, Non-existence of 390

Quinine in Jamaica Cinchonas 518

Radial Axle Boxes 535
Railway Wheels, Elastic 535
,, Tunnel through the Alps, Plate VII..... 157
Rainwater, Composition of .. 256, 525
Raphides.....251, 388, 518
Reason Why, The..... 94
Refrigerators..... 237
Respiration of Fruits 518
,, Products of 120
Reviews of Books .. 83, 217, 370, 501
Rhizopods, Variation of Species.. 425
Richardson, Dr. B. W., Greek Fire 164
Roberts, G. E., Pre-Historic Dwellings, Plate XV..... 362
Roots of Plants, Functions of.... 514
Rotifers, Vitality of..... 289
Rusts, Plates XII., XIII.–XX. 317, 469
Ruta-muraria, Peculiar Form of.. 387
Rutile, Reproduction of 126

Sagenite, Reproduction of..... 126
Salmon Characters of Male 424
Salt Water Entomostraca in Fresh Water..... 565
Satellites of Sirius..... 515
Savory, W., on Life and Death .. 379
Saxby, Weather System 508
Scapho-cephalic Skulls, Cause of 403
Schreibersite, Characters of..... 276
Scientific Summary.. 97, 243, 381, 514
Scotland, Ancient Shell Mounds 111
Sea Louse of the Baltic 423
Sewing Machines, Patent 79
Sharks, Fossil Fresh-water 262
Signal Lanterns..... 76
Signals, Faulkner's Electric Pit .. 547
Silica Compound, New..... 524
Silver in Copper Mines 125
,, Method for Extraction of.. 404
Sirenia, Skeleton of 288
Sirius, Companions of 98
Skin of Hands and Feet 119
Skin Parasites, Nature of 540
Smuts and Bunts 35
Smuts in Wheat, M. Lavalle's Conclusions 521
Soap for Dirty Hands 390
Soil, Character of, Population Dependent upon..... 382
Solid Bodies, Specific Heat of.... 135
Solar Discoveries, Nasmyth's 385
,, Envelope..... 516
,, Faculæ..... 99
,, Light, Analysis of 560
,, Rays Electric Agents..... 133
Sound, Laplace's Correction for Velocity of..... 284
Space, Motion of Solar System in 385

Spectra, Different, produced by same Element 558
Spectral Analysis, Use of Prisms 134
Spectral Lines, Numerical Nomenclature of 134
Spectroscopes 136, 280, 556
Speke, J. H., Source of Nile.... 373
Spermogones 30
Sphærularia Bombi 566
Spitzbergen Plants, Perennial.... 521
Spontaneous Generation 290
Stars, Catalogue of 246
,, Parallax of..... 385
,, Shooting..... 99
,, Variable..... 100, 245, 246
Static Electricity, Treatment of Asthma by..... 270
Steam Adheated 536
Steam Coals for Navy 535
Steam Fire-Engines, Trial of 117
Steel and Iron Prepared by Pneumatic Process..... 235
Steel, the Management of 96
Steel Rails..... 124
Stereoscopes 72
Storms, Magnetic..... 422
Stream of Life, by J. L. Milton 505
Striæ on Fossil Bones 114
Suboxide of Copper, to Prepare.. 525
Suez Canal..... 115
Suicide, Statistics of..... 543
Sulphate of Soda, Manufacture of 74
Sulphuric Acid, Pyrites used in .. 273
Sun, the 97, 243, 246, 382, 385
Surveying and Levelling Instruments..... 70
Symonds, Rev. S. W., Notes on Earthquakes 204

Tape-worm Affections, Oil of Fern in 400
Target, Mr. Reed's 265
Taurus, Variable Nebula in 384
Taylor's Geological Essays 507
Teetotalism, Last Blow to 400
Telegraphs, Printing, by R. S. Culley, Plate XI... 293
,, Magneto-Electric .. 69
Telescope, New..... 385
Telescopes, Clock Apparatus for.. 99
Temperature in Palæozoic Times, Earth's 258
Temperatures at which Metals Boil..... 421
Tennent's Story of the Guns 379
Tephroite, Characters of 549
Terminology, Pedantic..... 562
Testing of Chain Cables 536
Thallium 107, 121, 135, 389
Thermometry, by G. F. Chambers 487
Titanic Acid, Isomeric Forms of.. 393
Tortoises, Breeding of in this Country 139
Tortoise, Sternum of Fossil..... 260
Trichomanes radicans, Distribution 248
Tunicata, Morphology of..... 423
Tubularia not Parthenogenous .. 561

Uranus, Early Observations of .. 517
Urea, Increased by Electricity .. 544
Uric Acid, Decomposition of by Bromine..... 528

Vaccine and Variolus Virus 402
Valerylene..... 392
Vanadic Acid..... 110
Vegetation, Influence of Smoke on 388
Vegetable Tissues, Coloration of by Acids..... 104
Venus at Inferior Conjunction.... 245
Vessels, Steel..... 263
Vine and Epidemic Fungus, Identity of..... 519
Vital Phenomena, by Grindon.... 227
Voice, Cause of Falsetto 541
Volcano of Aconcagua..... 113

Water, Decomposition of 527
Weather-glass, Galileo's 420
Wheeler, J. T., Handbook to Cultivation of Cotton 380
Wildbad-Gastein, Thermal Waters 393
Wild Flowers and their Uses 95
Winneck's Comet 97
Wood's, Rev. J. G., Homes without Hands 511
,, ,, Our Garden Friends and Foes 224
,, Study of the Physical Sciences..... 512
Woodsia Glabella, Range of 520

Yellow Skin in Fever, Cause 400

Zircon, Forms of..... 409
Zoology for Schools 86
,, and Comparative Anatomy 136, 284, 422, 561

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